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THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 55 SEPTEMBER, 1934 No. 1

THE COMPOSITION OF PHILIPPINE WOODS, VII [1]

By F. M. YENKO, LUZ BAENS, and AUGUSTUS P. WEST

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and

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Of the Bureau of Forestry, Manila

EIGHT PLATES

This paper is a continuation of our work on the composition of Philippine (tropical) woods. Six papers have already appeared,[2] and this makes our seventh report.

For a number of years paper has been manufactured from the cellulose in wood. In recent years it has been found that many other commercial products can be made from wood cellulose. Paints, lacquers, plastic articles, artificial leather, rayon, cellophane, and other products are now made from wood cellulose.

Since wood is a very compact raw material, which can be easily obtained and handled, it naturally serves as one of the best sources of industrial cellulose. In addition to cellulose, wood contains other substances—oils, resins, gums, and an inert material known as lignin. In using wood cellulose for commercial purposes these foreign substances are separated from

[1] This work is carried on coöperatively by the division of chemical research, Bureau of Science, and the Bureau of Forestry.

[2] Yenko, F. M., Luz Baens, A. P. West, and H. M. Curran, Philip. Journ. Sci. 47 (1932) 281 and 343; 48 (1932) 299; 49 (1932) 587; 52 (1933) 209; 53 (1934) 489.

STI-12-8746

the cellulose, as otherwise they would contaminate and render it unsuitable for many purposes.

For industries that use wood as their basic raw material the composition of woods is a matter of considerable importance.

An account of the general properties of the woods recorded in this paper is given by Schneider.[3] Brief descriptions are as follows:

Bayok-bayókan (*Pterospermum niveum* Vid.) is a tree which grows to a diameter of 60 centimeters. As with other members of this genus the wood is rather tough, hard, and moderately heavy to heavy. It seasons well and is easy to work. Although it is not very durable (durability 4) it is rarely attacked by beetles. The texture is fine and smooth. The wood is used for posts, general construction work, and furniture. Good ties and paving blocks could be made from the wood if impregnated.

Gisok [*Shorea balangeran* (Korth.) Dyer] reaches a diameter of about 180 centimeters. The wood is hard, tough, heavy and very durable (durability 1). The texture is fine and dense. It is used for high-grade permanent construction, beams, bridges, hubs, spokes, ties, tools, and other purposes.

Salakin [*Aphanamixis cumingiana* (C. DC.) Harms] reaches a diameter of 50 centimeters. The wood is hard and heavy. The heartwood has a rich red color somewhat like a dark grade of cigar-box cedar. The texture is fine, smooth, and glossy. This wood has a pleasant odor, seasons well, and is easy to work. It has a durability of about 3 and is rarely attacked by beetles.

Terukan (*Beilschmiedia glomerata* Merr.) is a medium-sized tree. The wood is hard and rather heavy. It seasons fairly well and is easy to plane but rather difficult to saw. It is resistant to termites and other insects but not to decay. According to Mr. L. J. Reyes, wood technologist of the Bureau of Forestry, the wood of terukan resembles that of *Cryptocarya*.

Dungon-láte (*Heritiera littoralis* Dry.) is a tree that grows to a diameter of 90 centimeters. It has a rather short and generally irregular bole. The wood is hard, tough, and heavy. It has a durability of 1 and is rarely attacked by termites. It is used for piling, posts, ties, paving blocks, ship building, and other purposes. It has been recommended for steamed bent work where strength and durability are required.

[3] Bull. P. I. Bur. Forestry 14 (1916).

Lanútan [*Polyalthia rumphii* (Bl.) Merr.] is a medium-sized forest tree that grows to a diameter of about 30 centimeters. The wood is moderately hard and rather heavy. It seasons fairly well but is attacked by fungus stain. The wood is not very durable as it is susceptible to rot infection and is attacked by termites and other wood borers.

Vidal's lanútan [*Bombycidendron vidalianum* (Naves) Merr. and Rolfe] grows to a diameter of 40 centimeters. The wood is moderately hard, tough, and moderately heavy, and the texture fine and smooth. It seasons well, is fairly easy to work, and has a durability of 3. It is rarely attacked by beetles. It is used for posts, beams, tools, cabinetwork, and musical instruments, but particularly for shafts of vehicles.

Yakál [*Hopea plagata* (Blco.) Vid.] is a tall straight tree that grows to a diameter of 100 to 180 centimeters. The wood is very hard, tough, stiff, and very heavy, and the texture fine and dense. The durability is 1. It is used for posts, bridges, wharfs, tools, cabinetwork, ties, paving blocks, and other permanent construction work. The supply is usually abundant.

Ákle [*Albizzia acle* (Blco.) Merr.] grows to a diameter of 125 centimeters or more. It has a short bole that is often crooked. The sapwood is very perishable but the heartwood is durable. The heartwood has a strong peppery odor and the dust from it causes violent sneezing. This wood has a durability of 1 and is practically never attacked by insects. It is used for general construction, furniture, and all kinds of high-grade interior work.

Mahogany (*Swietenia mahagoni* Jacq.) is a tree that grows to a diameter of about 40 centimeters. The wood is hard and heavy. It seasons well and is easy to saw and plane. It is very durable and resistant to termites and other insects. It is a very good wood for furniture and high-grade interior work.

Malúgai (*Pometia pinnata* Forst.) grows to a diameter of 100 centimeters. The wood is hard, flexible, tough, and moderately heavy. It bends well when steamed. It seasons well and is fairly easy to work. The durability is 3. The sapwood is commonly attacked by insects and sometimes the damage extends into the heartwood. This wood is used for interior work, boats, tools, furniture, and other purposes.

Teak (*Tectona grandis* L. f.), according to Schneider,[4] is not native to the Philippines but was sparingly introduced so long ago that trees up to 80 centimeters in diameter have been found. It is reported from one or two localities in Luzon, from Cotabato, Zamboanga, Basilan, and the Sulu group. The teak used in the Philippines is imported. Teak is a rather hard wood that is moderately heavy. It seasons well and is very durable and easy to work. It is a very good wood for furniture and high-grade interior work.

Banabá [*Lagerstroemia speciosa* (L.) Pers.] has wood that is rather hard and heavy. It seasons fairly well and has a durability of 1. It is rarely attacked by termites and is used for various purposes such as paving blocks, general construction, interior finish, and furniture.

Banúyo (*Wallaceodendron celebicum* Koord.) grows to a diameter of 150 centimeters and has a short bole that is often crooked. The wood is moderately hard and heavy. It seasons very well, is easy to work, and has a durability of 3. The heartwood is rarely attacked by beetles. This wood is used for interior finish, windows, shell screens, furniture, musical instruments, and other purposes.

Bitaog (*Calophyllum inophyllum* L.) is also known by the Spanish name palomaria, or palomaria de la playa ("of the beach"). This tree reaches a diameter of 130 centimeters but generally has a very short and irregular bole. It is very common and well known and has been reported as growing in practically every Philippine province that has a sea coast. The wood is hard and heavy. The grain is generally curly, wavy, and crossed, making the wood difficult to split. The wood seasons well, has a durability of 2, and is rarely attacked by insects. It is used for posts, flooring, hubs, furniture, and other purposes.

Pahútan (*Mangifera altissima* Blco.) is one of the mango family of trees. It is a tall tree that grows to a diameter of 80 centimeters. The wood is moderately hard and heavy with a rather fine texture. It seasons well, though large knots sometimes check and the sapwood is liable to stain if not seasoned quickly. It is easy to work and takes a beautiful finish. The durability is 3. This wood is used for various purposes such as beams, door panels, furniture, chests, etc.

[4] Bull. P. I. Bur. Forestry 14 (1916) 207.

Ípil [*Intsia bijuga* (Colebr.) O. Ktze.] grows to a diameter of about 180 centimeters. The wood is hard and heavy with a grain that is straight or somewhat crossed. It has a durability of 1 except with regard to teredos. It is used in all high-class general construction, such as beams, ties, tools, agricultural implements, musical instruments, and for other purposes. On account of its hardness, stiffness, and great durability, it is one of the best woods in the Islands.

Láñgil [*Albizzia lebbeck* (L.) Benth.] is a small to medium-sized tree. The wood is hard and heavy, seasons well, and is easy to work. It has a durability of 2 and is rarely attacked by beetles. It is used for posts, ties, agricultural implements, and other purposes.

Liúsin [*Parinarium corymbosum* (Bl.) Miq.] grows to a diameter of 60 to 90 centimeters and sometimes even larger. The wood is hard and very heavy. The sapwood and heartwood are scarcely distinguishable. This wood is difficult to work as it rapidly dulls all tools. When it is in contact with the ground or exposed to the weather its durability is poor. However, it is rarely attacked by insects and is very resistant to teredos. When impregnated it is suitable for ties and paving blocks. It is a favorite of the charcoal burners of Bataan.

Moláve (*Vitex parviflora* Juss.) is, excepting narra, the most highly esteemed and most variously used wood in the Philippines. This tree grows to a diameter of 200 centimeters or more and generally has a short, crooked, and fluted bole. The wood is hard, stiff, brittle, and heavy. It is easy to work, perhaps the easiest of all Philippine woods of equal hardness and density. It has a durability of 1 and is rarely attacked by termites. It is employed in all kinds of construction such as piles, beams, ties, flooring, furniture, sculpture, carving, wood-cut engraving, tools, pestles, mortars, and agricultural implements.

Pagsahíñgin [*Canarium villosum* (Bl.) F. Vill.] is probably the largest and most widely distributed species of this genus. It grows to a diameter of 100 centimeters or more. The wood is moderately hard and moderately heavy. It seasons well, is rather easy to work, and is subject to the attacks of beetles; it is used for cheap construction. The durability is 4.

Sibukau (*Caesalpinia sappan* L.) is a small straggling tree that grows to a diameter of 15 to 20 centimeters. It is known from northern Luzon to Mindanao. This wood is practically

TABLE 1.—*Measurements of trees used for wood analyses.*

Name of tree.	Diameter.	Total height.	Clear length of trunk.	Height from which specimen was taken.
	cm.	*m.*	*m.*	*m.*
Bayok-bayókan; *Pterospermum niveum*	15.0	8.40	4.60	2.10
Gisok; *Shorea balangeran* [a]				
Salakin; *Aphanamixis cumingiana*	12.6	9.70	3.40	0.30
Terukan; *Beilschmiedia glomerata*	19.0	12.10	8.00	0.50
Duñgon-láte; *Heritiera littoralis* [a]				
Lanútan; *Polyalthia rumphii*	24.0	11.90	5.70	0.50
Vidal's lanútan; *Bombycidendron vidalianum*	25.0	15.10	5.40	0.50
Yakál; *Hopea plagata* [a]				
Akle; *Albizzia acle*	13.4	8.01	1.95	1.11
Mahogany; *Swietenia mahagoni*	17.1	10.70	2.20	0.10
Malúgai; *Pometia pinnata*	23.0	15.80	6.70	6.00
Teak; *Tectona grandis*	37.0	17.00	2.80	1.41
Banabá; *Lagerstroemia speciosa*	15.2	10.50	1.96	0.33
Banúyo; *Wallaceodendron celebicum*	22.5	14.50	3.00	0.55
Bitaog; *Calophyllum inophyllum*	36.8	19.32	1.93	3.50
Pahútan; *Mangifera altissima* [a]				
Ípil; *Intsia bijuga*	37.4	16.83	1.38	0.68
Lañgil; *Albizzia lebbeck*	27.6	16.73	5.00	2.75
Liúsin; *Parinarium corymbosum*	16.5	9.59	1.88	0.16
Moláve; *Vitex parviflora*	21.3	11.20	4.20	1.18
Pagsahíñgin; *Canarium villosum*	29.7	12.31	2.34	4.33
Sibukáu; *Caesalpinia sappan*	9.0	9.00	0.70	0.05
Talísai; *Terminalia catappa*	14.7	7.16	4.90	0.73
Tíndalo; *Pahudia rhomboidea*	5.8	5.86	1.67	1.28

[a] These woods were of average mature size. Exact measurements were not made.

lowing common names: Bayok-bayókan, gisok, salakin, terukan, duñgon-láte, lanútan, Vidal's lanútan, yakál, akle, mahogany, malúgai, teak, banabá, banúyo, bitaog, pahútan, ípil, lañgil, liúsin, moláve, pagsahíñgin, sibukau, talísai, and tíndalo.

As shown by the data (Table 2) ípil has the highest cellulose content and duñgon-láte the lowest. Duñgon-láte has the highest lignin and mahogany the lowest. The highest alpha cellulose was given by bayok-bayókan and sibukau gave the lowest. Liúsin has the highest ash content and Vidal's lanútan the lowest.

ACKNOWLEDGMENT

The authors wish to thank Mr. Mamerto D. Sulit, of the Philippine Bureau of Forestry, for checking the scientific names of the woods recorded in this paper.

TABLE 2.—*Analysis of Philippine woods.*

Constituent.	Bayok-bayókan; *Pterospermum niveum.*	Gisok; *Shorea balangeran.*	Salakin; *Aphanamixis cumingiana.*	Terukan; *Beilschmiedia glomerata.*	Duñgon-láte; *Heritiera littoralis.*	Lanútan; *Polyalthia rumphii.*
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Cold-water soluble	1.79	3.52	3.78	8.06	6.11	5.19
Hot-water soluble	2.18	5.44	7.60	5.50	12.12	11.14
Alkali soluble	12.48	19.24	17.75	16.03	26.72	19.52
Ether extract	1.03	2.74	0.47	0.66	1.97	0.47
Alcohol extract	2.18	4.18	3.07	3.06	7.06	4.69
Ash	0.91	1.14	2.72	1.11	2.45	1.93
Nitrogen	0.32	0.28	0.30	0.38	0.38	0.55
Lignin	32.50	29.51	63.26	24.99	40.03	27.63
Cellulose	55.84	49.46	50.49	45.46	40.66	45.53
Ash (determined) in cellulose	0.38	0.30	1.48	0.22	0.78	0.24
Cellulose (ash free)	55.46	49.16	49.01	45.24	39.88	45.29
Alpha cellulose in total cellulose	79.20	81.27	79.36	73.17	78.57	73.95
Alpha cellulose in the wood	44.23	40.20	40.07	33.26	31.95	33.70

Constituent.	Vidal's lanútan; *Bombycidendron vidalianum.*	Yakál; *Hopea plagata.*	Akle; *Albizzia acle.*	Mahogany; *Swietenia mahagoni.*	Malúgai; *Pometia pinnata.*	Teak; *Tectona grandis.*
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Cold-water soluble	0.53	5.92	4.97	7.51	6.74	7.40
Hot-water soluble	2.87	8.96	12.36	11.70	7.65	11.05
Alkali soluble	13.85	23.67	16.92	19.76	12.50	21.80
Ether extract	0.37	6.18	0.91	3.94	0.58	2.81
Alcohol extract	2.49	7.48	6.77	7.35	9.98	3.74
Ash	0.45	1.95	1.11	0.75	1.36	1.74
Nitrogen	0.18	0.35	0.44	0.48	0.28	0.35
Lignin	29.46	34.21	33.15	24.95	37.29	34.83
Cellulose	56.83	41.50	45.75	49.57	43.97	44.95
Ash (determined) in cellulose	.13	0.27	0.55	0.27	0.21	0.49
Cellulose (ash free)	56.70	41.23	45.20	49.30	43.76	44.46
Alpha cellulose in total cellulose	66.05	75.44	70.33	72.91	71.00	73.14
Alpha cellulose in the wood	37.54	31.31	32.18	36.14	31.22	32.88

TABLE 2.—*Analysis of Philippine woods*—Continued.

Constituent.	Banabá; *Lagerstroemia speciosa.*	Banúyo; *Wallaceodendron celebicum.*	Bitaog; *Calophyllum inophyllum.*	Pahútan; *Mangifera altissima.*	Ípil; *Intsia bijuga.*	Lañgil; *Albizzia lebbeck.*
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Cold-water soluble	2.56	1.20	1.91	2.23	4.82	5.26
Hot-water soluble	8.98	3.90	3.58	5.16	11.00	10.75
Alkali soluble	18.24	13.76	15.54	13.53	22.44	20.53
Ether extract	0.16	1.36	0.35	0.28	1.20	0.46
Alcohol extract	1.80	2.50	4.21	4.66	6.89	5.78
Ash	2.27	1.18	0.47	0.65	1.25	0.46
Nitrogen	0.52	0.29	0.18	0.14	0.39	0.39
Lignin	34.90	32.00	38.41	31.23	32.70	27.90
Cellulose	45.73	52.62	48.97	54.07	57.81	49.05
Ash (determined) in cellulose	0.56	0.57	0.18	0.20	0.31	0.20
Cellulose (ash free)	45.17	52.05	48.79	53.87	57.50	48.85
Alpha cellulose in total cellulose	74.68	75.34	69.69	71.05	71.46	71.46
Alpha cellulose in the wood	34.15	39.64	34.13	38.42	41.31	35.05

Constituent.	Liúsin; *Parinarium corymbosum.*	Moláve; *Vitex parviflora.*	Pagsahiñgin; *Canarium villosum.*	Sibukáu; *Caesalpinia sappan.*	Talísai; *Terminalia catappa.*	Tíndalo; *Pahudia rhomboidea.*
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Cold-water soluble	1.46	0.05	4.10	5.48	5.35	4.43
Hot-water soluble	4.55	2.33	14.61	9.47	11.05	8.34
Alkali soluble	13.41	6.95	29.03	24.03	18.61	26.10
Ether extract	0.96	0.68	0.17	0.35	0.44	0.51
Alcohol extract	2.51	7.83	2.32	7.37	5.06	3.07
Ash	3.72	1.56	2.08	0.81	0.72	0.89
Nitrogen	0.29	0.43	0.21	0.45	0.31	0.65
Lignin	35.96	38.85	25.83	32.00	32.72	25.59
Cellulose	50.59	49.54	46.10	45.27	44.98	44.80
Ash (determined) in cellulose	2.27	0.20	0.84	0.10	0.28	0.13
Cellulose (ash free)	48.32	49.34	45.26	45.17	44.70	44.67
Alpha cellulose in total cellulose	73.88	72.97	70.04	63.28	66.77	72.64
Alpha cellulose in the wood	37.38	36.15	32.29	28.65	30.03	32.54

ILLUSTRATIONS

PLATE 1

FIG. 1. Bayok-bayókan; *Pterospermum niveum* Vid.
2. Salakin; *Aphanamixis cumingiana* (C. DC.) Harms.
3. Terukan; *Beilschmiedia glomerata* Merr.

PLATE 2

FIG. 1. Duñgon-láte; *Heritiera littoralis* Dry.
2. Lanutan; *Polyalthia rumphii* (Bl.) Merr.
3. Vidal's lanutan; *Bombycidendron vidalianum* (Naves) Merr. and Rolfe.

PLATE 3

FIG. 1. Yakál; *Hopea plagata* (Blco.) Vid.
2. Akle; *Albizzia acle* (Blco.) Merr.
3. Mahogany; *Swietenia mahagoni* Jacq.

PLATE 4

FIG. 1. Malúgai; *Pometia pinnata* Forst.
2. Teak; *Tectona grandis* L. f.
3. Banabá; *Lagerstroemia speciosa* Pers.

PLATE 5

FIG. 1. Banuyó; *Wallaceodendron celebicum* Koord.
2. Bitaog; *Calophyllum inophyllum* L.
3. Pahútan; *Mangifera altissima* Blco.

PLATE 6

FIG. 1. Liusin; *Parinarium corymbosum* (Bl.) Miq.
2. Lañgil; *Albizzia lebbeck* (L.) Benth.

PLATE 7

FIG. 1. Ipil; *Intsia bijuga* O. Ktze.
2. Moláve; *Vitex parviflora* Juss.
3. Pagsahiñgin; *Canarium villosum* F.-Vill.

PLATE 8

FIG. 1. Sibukau; *Caesalpinia sappan* L.
2. Talísai; *Terminalia catappa* L.
3. Tíndalo; *Pahudia rhomboidea* (Blco.) Prain.

PLATE 1.

PLATE 2.

PLATE 3.

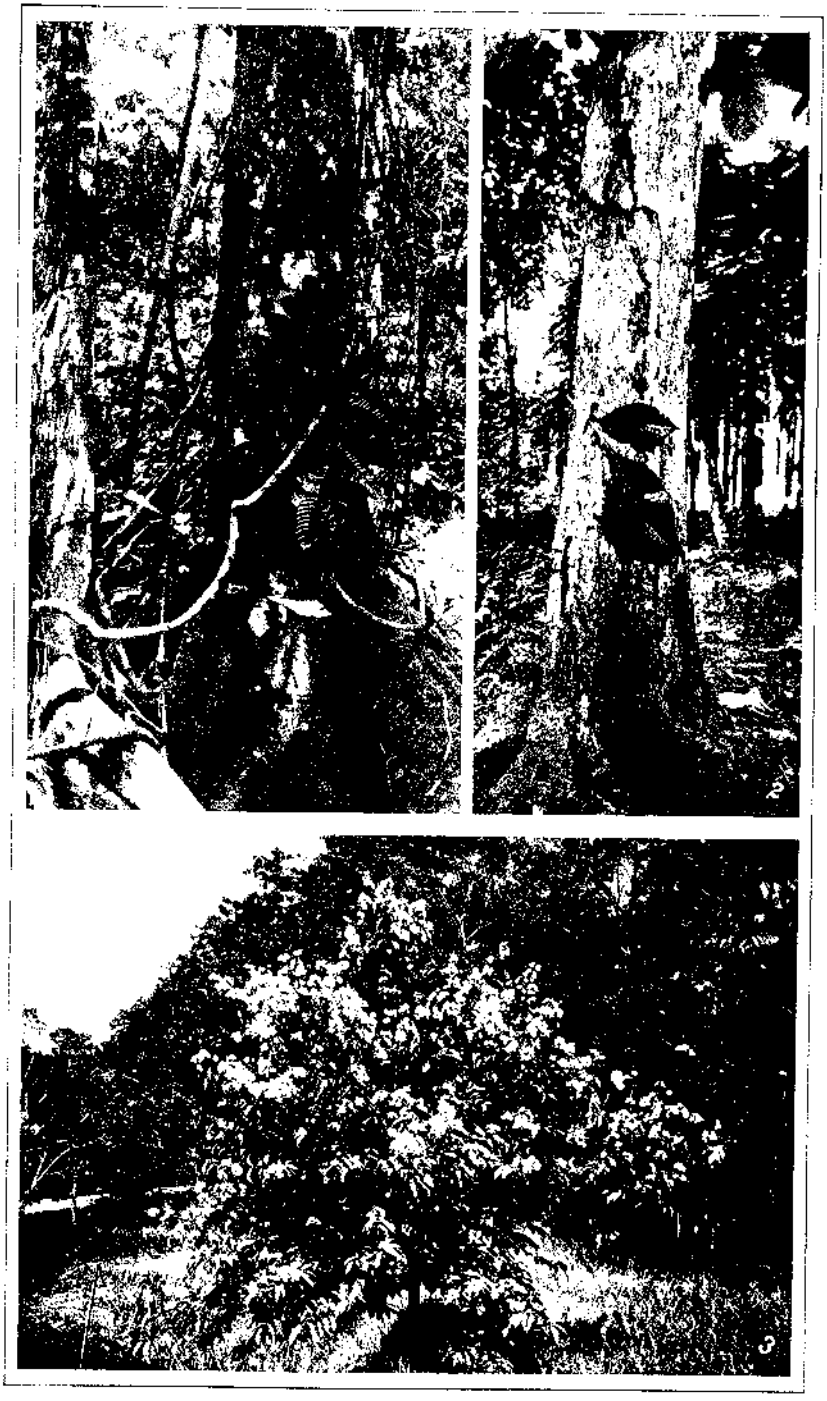

PLATE 4.

PLATE 5.

PLATE 6.

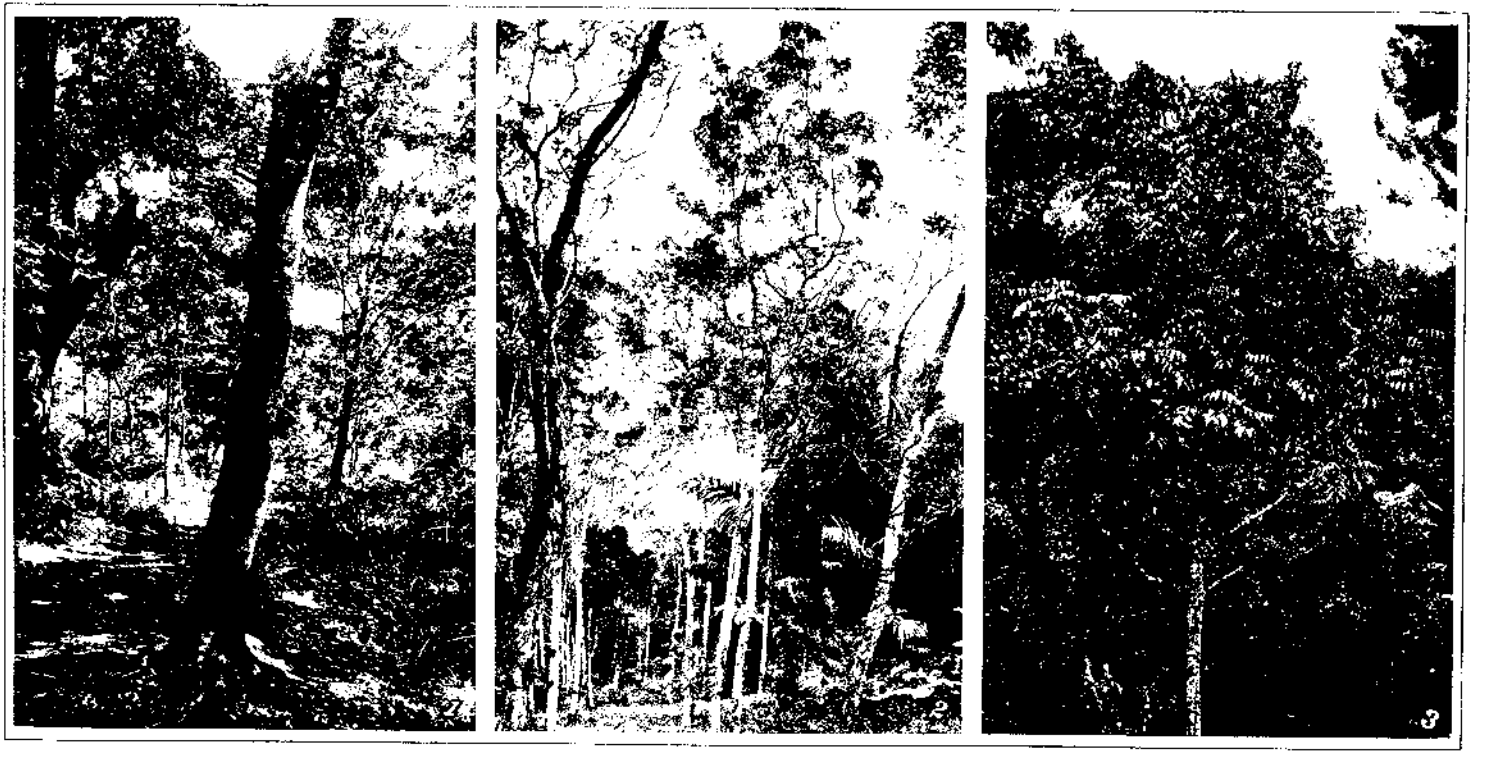

PLATE 7.

PLATE 8.

THE PHYSIOLOGY OF REPRODUCTION IN SWINE, II

SOME OBSERVATIONS ON MATING [1]

By AGUSTIN RODOLFO

Formerly Geneticist of the All-Union Research Institute for Swine Husbandry, Poltava, Ukraine, U. S. S. R.

This paper is devoted to a study of the mating behavior of swine in the hope that it may add a little to the cumulating knowledge about the biology of this economic animal. The mating behavior of the boar is described, and from the observations made some facts are adduced which throw light on natural insemination in the sow. Attention is focused on the different adaptive means possessed by the boar for depositing the semen during mating. The writer's interest was attracted to this phase of reproductive physiology by studies he was concurrently conducting on the technic of artificial insemination in swine.

MATERIALS

The boars upon which these observations were made belong to the batch of experimental animals reported on in the first paper of this series, and the observations were made in the course of the experiments reported in that paper.

OBSERVATIONS

(*a*) *The mating behavior of the boar.*—Since sows in heat were not always available as decoys, it was necessary to use animals that were not in heat. The sow was tied with a strong rope in a breeding crate so that the boar could mount without her being able to side-step readily. Failure to collect semen at the beginning of the experiment was provisionally explained by the hypothesis that perhaps the sow in heat emitted some sort of an essence which stimulated or excited the boar sexually and in the absence of which the boar would not mate properly. The consideration of a number of facts soon proved this hypo-

[1] This is the second paper of a series the materials for which were worked out during the writer's stay in Soviet Russia.

thesis untenable. First, as a little practice was obtained the collection of semen from boars that mounted a tied sow not in heat became quite easy. Second, it was later found that the boar will readily mount a dummy sow, which, as a matter of fact, was found to be very convenient to use as decoy. Third, it is a matter of common observation that boars accustomed to living together in the same pen oftentimes mount one another with an accompanying emission of the first two secretions. All these facts tend to show that sexual attraction at most plays only an insignificant rôle in the mating of the boar.

The boar's sexual behavior may be analyzed into relatively simple components. The presence of a sow that does not even have to be in heat, or the presence of a mere dummy sow, constitutes the stimulus to which the boar reacts by mounting. Then, when the boar has assumed the normal mating position, the insertion of the penis into the vagina, or into an artificial vagina—a simple mechanical device possessing warmth (36° to 40° C.), softness, and pulsating pressure—constitutes the other stimulus necessary for the completion of the coitus. It does appear then as if, as far as the boar is concerned, coitus is largely a mechanical process.

For the boar to give the full ejection, the penis must receive warmth, and, just as important, a gentle pulsating pressure. If the artificial vagina is too short, say only 24 cm long, as was the first instrument I had been using, the distal end of the penis often gets beyond the vaginal wall into the bottle, the semen container, a space lacking both the necessary warmth and pressure—the penis sometimes gets as deep as 35 cm. (For a description of the vagina and its construction see the first paper of this series.) As soon as this happens, the boar withdraws the penis entirely and becomes nervous; often he dismounts to begin the mating act all over again. There are some boars, however, that are not disturbed by the lack of both pressure and warmth on the distal end of the penis. These boars are interesting because they give some information on how the semen is deposited during natural insemination.

If the penis is properly lodged, ejection immediately follows. The first two secretions accompany the insertion of the penis into the vagina; as a matter of fact, these two secretions are sometimes squirted even without the penis getting in contact with anything. These first two secretions are composed of a translucent substance coagulated into relatively small masses, and a

straw-colored viscous liquid. The milky spermatozoa-bearing ejection soon follows. The manner in which ejection takes place may be observed with boars that are not disturbed by the distal end of the penis getting beyond the wall of the artificial vagina where warmth and pulsating pressure are lacking. A study of the movements of the penis of such a boar, when it gets beyond the walls of the artificial vagina into the glass semen container, allows the making of the following observations:

The distal end of the penis rotates forward in a counterclockwise, lefthand screw manner, and the milky ejection is given off at the end of this motion. After the semen is squirted, the distal end of the penis is withdrawn a little, rotating clockwise. These two motions are repeated alternatingly until apparently all of the spermatozoa-laden secretion has been ejected. After the ejection of the milky secretion the glans is retracted and held at rest while a straw-colored ejection is given off profusely. It seems as though this straw-colored ejection, apparently one of the first two secretions noted above, constituted the bulk of the semen.

That the first two secretions are given off profusely is also seen from the fact that when the penis is not properly lodged the boar may continue to jerk back and forth violently, meanwhile squirting the first secretions. In each of four notable instances more than two hundred cubic centimeters of alkaline secretions without spermatozoa were collected from three different boars. Boar No. 2196/87 on June 6, 1931, gave 200 cc, and on June 16, 345 cc of this straw-colored viscous secretion. Neither lot of samples contained spermatozoa, and both were alkaline with pH = 7.9. Boar No. 2200/91, on June 6, 1931, gave 425 cc of secretions without spermatozoa. This had a pH of 8.1. Boar 2695/178 gave, on June 22, 1931, 289 cc of alkaline secretions; pH = 8.1. All the pH determinations were made colorimetrically.

The above data permit of no doubt that the first two secretions are given off in profuse amounts, and strongly suggest that these secretions constitute the bulk of the semen.

(*c*) *Natural insemination.*—A clear understanding of the processes taking place in natural insemination is needed for the effective study of the problems pertaining to artificial insemination. In order to facilitate a better understanding of the various adaptations possessed by the boar for depositing the

semen into the uterus, some measurements made on the different parts of the sexual organs of the sow are given in Table 1.

TABLE 1.—*Length of the different parts of the genital system of the sow.*

Organ.	Number measured.	Average length.
		cm.
Vestibule	26	10.3
Sphincter		
Vagina	26	14.2
Uterus:		
Cervix	26	19.2
Cornua:		
Right	26	129.1
Left	26	128.3
Fallopian tubes:		
Right	25	26.4
Left	25	25.6

The above measurements show that the genital tract of the sow assumes relatively long proportions.

The length of the cornua, which constitutes the longest part of the tract, varies widely. Even among the small number of measurements that this writer made, a variation ranging from 85 cm to 205 cm has been observed.

When the sow is not in heat, the opening from the vestibule into the vagina is closed by the sphincter, which seems to relax only during œstrum. At least it is impossible to insert readily into the vagina a catheter of about the same thickness as the boar's penis during anœstrum. The cervix of the uterus, because of its rugate thick wall, has a very narrow and crooked canal which the penis probably could not penetrate much farther than the large rugæ at the entrance.

The extraordinary length of the genital tract of the sow and the presence of obstructions, such as the sphincter and the rugate thick-walled cervix, call for special adaptations on the part of the boar for the deposition of the semen in a manner such that the spermatozoa may easily be carried into the Fallopian tubes where fertilization probably takes place. And what are these adaptations?

The first of these adaptations is the lefthand-corkscrew-shaped distal end of the penis. From observations made with boars ejecting into a short artificial vagina, a picture of what takes place in natural mating may be inferred. Prior to the

ejection of the spermatozoa-laden milky fluid, the penis moves forward in a counter-clockwise manner. This counter-clockwise motion is doubtless a means to enable the lefthand-corkscrew-shaped distal end of the penis to penetrate as deeply as possible into the thick-walled cervix, probably a little beyond the large rugæ at the entrance, before the spermatozoa-laden liquid is ejected. In some boars the penis continues to move counter-clockwise and clockwise alternatingly during the ejection of the spermatozoa-bearing secretion; that is, it is thrust, retracted a little, and then thrust again, until the ejection of the spermatozoa-laden secretion has been completed. This first adaptation, therefore, may constitute a means of depositing the spermatozoa-bearing secretion directly into the cervix of the uterus.

The second adaptation is the large volume of the semen. As was pointed out in the first paper of this series,[2] the average volume of the semen of a lightly mated boar is 254.8 cc. It was also noted that this amount may be as large as 540 cc.

After the ejection of the milky spermatozoa-laden secretion, the distal end of the penis is probably retracted 5 to 10 cm into the vagina proper, and while remaining quite still it gives off considerable quantities of what appear to be of the first two secretions. It was noted above that these two secretions, especially the one given off after the spermatozoa-bearing ejection, are secreted profusely, as much as 425 cc having been collected at one time. Now, what are some of the functions of these two secretions?

The first two secretions are given off at the beginning of the coitus apparently to act as lubricant for the penis and to neutralize any acid reaction that may be present in the vagina and uterus. It will be recalled that these secretions are distinctly alkaline. After the ejection of the spermatozoa-bearing fluid at least one of these secretions, if not both, gives volume to the sperm, enabling it to flow down the long cornua into the Fallopian tubes. Because of the extraordinary length of the cornua, it is necessary for the semen to have a large volume if it is to reach the Fallopian tubes; a small volume is easily dissipated by being adsorbed by the walls of the cornua before it can flow very far. A large volume of semen is, therefore, really an important adaptive factor to insure fertilization.

[2] Philip. Journ. Sci. 53 (1934) 183–205.

This author has some data which show that the spermatozoa get into the Fallopian tubes within 40 minutes after a sow in heat was artificially inseminated. In getting there they had to traverse about 20 cm of cervix and 140 cm of cornus. It is apparent that without the aid of the pressure due to the volume of the semen, the spermatozoa by themselves cannot wiggle their way through 160 cm within 40 minutes.

The third adaptation is the vaginal plug or "bouchon vaginal." This is a coagulated, sticky, tough, mucinous white substance, usually the last secretion of the boar during the sexual act. The fact that in experimental work the plug is generally found sticking quite closely to the walls of the artificial vagina, precludes any suggestion of it being a female product, or that the vagina has anything to do with its formation. The voluminous amount of the semen undoubtedly causes the development of a relatively large pressure within the genital tract. The pressure in turn produces a tendency to outflow, and the vaginal plug probably plays a very important rôle in preventing such an outflow and in forcing the semen to flow towards the Fallopian tubes instead.

SUMMARY

1. It has been pointed out that sexual attraction plays an insignificant rôle in the mating behavior of the boar. For complete ejection a dummy sow and a properly prepared artificial vagina are needed.

2. Measurements are given of the genital tract of the sow. The average length of the two cornua and Fallopian tubes, and the cervix, vagina, and vestibule combined, amounts to 354.1 cm, or about 3.5 meters.

3. The adaptations possessed by the boar for so depositing the semen into the long genital tract that fertilization will be insured have been analyzed. These are:

(*a*) The ejection of the semen directly into the cervix of the uterus by means of the lefthand-corkscrew-shaped glans moving forward in a lefthand-screw manner.

(*b*) The large volume of the semen.

(*c*) The presence of the vaginal plug which prevents an outward flow of the semen.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XXI[1]

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THREE PLATES

The crane flies discussed at this time are chiefly from Formosa, where the majority were taken by Prof. Syûti Issiki, to whom I am greatly indebted for the privilege of retaining the material. Other Formosan species described here were taken in 1932 by Prof. Teiso Esaki; the types of such specimens are preserved in the Entomological Museum, Kiushiu Imperial University. A third important source of specimens is included in a series taken in the Diamond Mountains (Kongo San, Keumkang San), of Korea, by Prof. Jiro Machida, together with fewer specimens taken by the same scientist in Formosa and Honshiu; these specimens are in my own collection, through the kindly interest of Professor Machida. Other species from Korea that are discussed here and in the succeedings part under this general title, were taken by Prof. Jujiro Masaki and his colleagues, Messrs. I. Tabashi and C. Takeya; the 1930 and earlier collections from Masaki are in my collection, with duplicate numbers in the Agricultural Experiment Station of Chosen, at Suigen; the 1931 and later collections were sent to Professor Esaki and thence to me, the types being returned to Esaki, with duplicate numbers in my collection and at Suigen. I express my continued gratitude to all of the above-mentioned entomologists for this further coöperation in making known the tipulid fauna of the Japanese Empire.

The Issiki collections made in the mountains of southern Formosa have resulted in adding three subgeneric groups of Tipulidæ to those known from Japan and Formosa; namely, *Trichotipula* Alexander, *Dolichopeza* Curtis, s. s., and *Mitopeza* Edwards, as well as two others, *Elliptera* Schiner and *Helobia* St. Fargeau, to the known fauna of Formosa. Several other Pa-

[1] Contribution from the entomological laboratory, Massachusetts State College.

læarctic groups were likewise discovered in southern Formosa, south of the Tropic of Cancer, in these cases representing the most southerly distribution in eastern Asia; such additional groups are *Dictenidia* Brullé, *Dicranoptycha* Osten Sacken, *Rhaphidolabis* Osten Sacken, and *Ormosia* Rondani.

In order to complete the record, I have included one species of *Trichocera*, of the family Trichoceridæ.

TRICHOCERIDÆ

TRICHOCERA MIRABILIS sp. nov. Plate 1, fig. 1; Plate 2, fig. 25.

Size large (wing, over 8 millimeters); general coloration dark brown, sparsely dusted with grayish yellow pollen; anterior pleurites brownish black, the posterior ones paler; femora brownish yellow, the tips narrowly dark brown; wings brownish yellow, the prearcular region pale yellow; stigma pale brown; very restricted dark clouds on r-m and m-cu; abdomen dark brown; male hypopygium with the tergite produced medially into a narrow darkened lobe, its apex truncated; dististyle elongate, with a long lobe near base and a second pale lobule at near two-thirds the length.

Male.—Length, about 8 millimeters; wing, 8.5.

Female.—Length, about 7.5 millimeters; wing, 8.5.

Rostrum dark gray; palpi black. Antennæ with scape and pedicel light brown; basal flagellar segment dark brown, remainder of flagellum black. Head gray.

Mesonotal præscutum and scutum chiefly dark brown, sparsely dusted with grayish yellow pollen; scutellum somewhat paler, especially the posterior border which is obscure yellow; mediotergite brown. Pleura with propleura, anepisternum, sternopleurite, and ventral meron brownish black, the posterior sclerites paler brown. Halteres elongate, yellow, the slender knobs dusky. Legs with the fore coxæ brownish black, the remaining coxæ and all trochanters brownish yellow; femora obscure brownish yellow, clearer yellow basally, the tips narrowly dark brown; tibiæ brownish black, the tips narrowly darker; tarsi black. Wings (Plate 1, fig. 1) with a brownish yellow tinge, the prearcular region pale yellow; stigma pale brown; very restricted dark clouds on r-m and m-cu more evident in female; veins brown, brighter in the prearcular field. Macrotrichia of veins long and conspicuous, including series on the crossveins m and m-cu. Venation: Sc_1 ending just before R_2; R_{2+3+4} a little shorter than R_{2+3}; m-cu at or just before outer end of cell 1st M_2.

Abdomen dark brown, hypopygium more yellowish. Male hypopygium (Plate 2, fig. 25) with the tergite, 9*t*, narrowly transverse, the median area produced into a slender darkened lobe, its apex truncate. Basistyle, *b*, with mesal lobe small, basal in position. Dististyle, *d*, elongate, near base on mesal face with a slender lobe that is about two-fifths the length of entire style, its apex a little expanded and provided with abundant setulæ; main axis of style at near two-thirds the length with an oval pale lobule set with several long setæ; apical third of style a clavate structure that is fringed with abundant strong spinous setæ on outer face of distal half. Gonapophyses, *g*, conspicuous, long and slender, gently curved. Ovipositor with cerci elongate, yellowish horn color.

Habitat.—Korea.

Holotype, male, Kongo San, October 18, 1933 (*Machida*). Allotopotype, female, October 8, 1933 (*Machida*).

This rather remarkable fly needs no comparison with any other described species of the genus. In its large size it approaches the stature of the genus *Diazosma* Bergroth but is a true *Trichocera*. The structure of the male hypopygium is unusually complicated, suggesting in some respects *T. lutea* Becher (Western Palæarctic) and *T. salmani* Alexander (Eastern Nearctic), yet is very different in all details.

TIPULIDÆ

TIPULINÆ

DICTENIDIA INÆQUIPECTINATA sp. nov. Plate 1, fig. 2.

Head brownish yellow; antennæ (male) very long, with long unequal branches, the longest fully three times as long as the segments; mesonotal præscutum with three black stripes; pleura yellow, unmarked; tips of femora blackened; posterior femora with a narrow yellow subterminal ring; posterior tibiæ chiefly dirty white, only the narrow bases and tips darkened; wings tinged with yellow, the stigma and cord restrictedly seamed with brown; wing tip undarkened and without macrotrichia in the cells; abdominal segments one to five yellow, the tergites with an interrupted black dorsal stripe, segments six to nine black.

Male.—Length, about 11 millimeters; wing, 12; antenna, about 5.5.

Frontal prolongation of head yellow, with coarse black setæ, especially on nasal region; palpi brownish yellow, the terminal

segments dark brown. Antennæ elongate, approximately one-half as long as entire body; scape pale yellow; pedicel a trifle darker; flagellar segments bicolorous, the axis and branches dark brown, the outer end of axis of individual segments pale yellow, on outer two segments uniformly darkened; basal flagellar branches elongate, the longest (about flagellar segments seven to nine) fully three times the segments; apical flagellar branches long and slender but conspicuously thinner and shorter than the basal branches of the same segment; in *formosana* both branches are subequal in length and the outer one is only a trifle slenderer than the basal one; terminal segment elongate, fully one-half longer than the penultimate. Head yellow, with a faint brown tinge, but quite immaculate.

Pronotum yellow. Mesonotal præscutum yellow, with three intensely black stripes that are very slightly covered with delicate yellow setulæ to appear like a bloom; scutal lobes similarly blackened; scutellum dark brown, the parascutella pale; mediotergite pale reddish yellow. Pleura yellow. Halteres yellow, the knobs weakly infuscated. Legs with the coxæ and trochanters yellow; fore and middle femora brownish yellow, the tips broadly and conspicuously blackened, the bases narrowly clearer yellow; posterior femora more enlarged and with a narrow, clearer yellow ring before the blackened tips and about one-half as wide as the latter; fore and middle tibiæ almost uniformly blackened; posterior tibiæ narrowly blackened at base, the amount subequal to the dark femoral tips, the apices similarly narrowly darkened, the entire intermediate portion, embracing more than five-sixth of the segment, dirty white; tarsi black. Wings (Plate 1, fig. 2) tinged with yellow, the prearcular region and cells C, Sc, and Cu_1 clearer yellow; stigma oval, brown; a slightly paler brown cloud on anterior cord and a very narrow seam on m-cu; wing tip undarkened; veins brown, more yellow in the flavous areas. No macrotrichia in apical cells of wing, as is the case in all other members of the genus. Venation: Sc_1 indicated by a weak spur; M_{3+4} a little more than one-half m; petiole of cell M_1 a little shorter than m.

Abdominal tergites one to five obscure yellow, narrowly blackened medially, the caudal borders of the intermediate segments broadly grayish white; sternites one to five similarly obscure yellow; segments six to nine, with all appendages, intense black; vestiture of hypopygium black, of remainder of abdomen, yellow.

Habitat.—Formosa.

Holotype, male, Kanshirei, altitude 1,500 feet, May 13, 1933 (*Issiki*). Paratypes, 2 males, Arisan, June 6, 1932 (*Gressitt*).

Dictenidia inæquipectinata is so different from all other described species of the genus that it scarcely requires comparison with any. The lack of macrotrichia in the wing cells and the unusually long antennæ of the male, with very long unequal branches, are the most conspicuous specific characters. *Dictenidia sauteri* Enderlein[2] is at most a color variety of *D. formosana* Alexander.[3]

DOLICHOPEZA (DOLICHOPEZA) ISSIKIELLA sp. nov. Plate 1, fig. 3.

Mesonotum dark reddish brown, variegated with more grayish brown; legs very long; posterior tibiæ and tarsi entirely snowy white; central portion of anterior tibiæ and proximal ends of basitarsi more darkened; wings strongly infumed, the large stigma even darker brown; conspicuous cream-colored areas before and beyond stigma; Rs short, its origin opposite termination of Sc_2; abdominal segments conspicuously variegated with brownish yellow, dark brown, and silvery white.

Female.—Length, about 14 millimeters; wing, 11.5.

Frontal prolongation of head brownish black; palpi black. Antennæ with scape and pedicel light yellow, flagellum brownish black; flagellar segments cylindrical, with short verticils. Head behind gray, the front more silvery; a capillary brown vitta extends from the region of the vertical tubercle almost to occiput; anterior vertex wide, approximately five times the diameter of scape.

Mesonotal præscutum with the ground color on sides dark reddish brown, the lateral stripes slightly differentiated by a sparse pruinosity; intermediate stripes more pruinose on anterior ends, behind concolorous with the lateral margins; humeral region and anterior interspaces very restrictedly light gray; scutum dark reddish brown; scutellum dark brown medially, the posterior lateral portions broadly yellow, the parascutella reddish brown; mediotergite dark brown, the lateral borders somewhat paler. Pleura variegated dark brown and testaceous, the pale color including chiefly the pteropleurite and meral region. Halteres with stem obscure whitish, the extreme base brighter, the knobs dark brown. Legs with the fore coxæ chiefly dark brown, the other coxæ darkened basally with the tips broadly pale; trochanters whitish; femora dirty brownish white, the tips

[2] Zool. Anzeig. 52 (1921) 225–226.
[3] Ann. Ent. Soc. Am. 13 (1920) 261–262.

insensibly darkened; posterior tibiæ and tarsi entirely snowy white; remaining legs detached, but one pair shows the extensive central portion of tibiæ pale brown, the bases somewhat narrowly, the tips broadly snowy white; tarsi snowy white, the proximal ends of basitarsi slightly darkened; legs unusually long and slender. Wings (Plate 1, fig. 3) with the ground color very strongly infumed, the costal region and narrow apical border to opposite vein Cu_1 even more darkened; stigma large, oval, dark brown; conspicuous cream-colored obliterative areas before and beyond stigma; veins dark brown. Venation: Rs short, in oblique to subtransverse alignment with the basal section of R_{4+5} and only a little longer than this element; Sc_2 ending exactly opposite origin of Rs; R_{1+2} entirely atrophied; medial forks of moderate depth; m-cu at fork of M.

Abdominal segments conspicuously variegated with brownish yellow, dark brown, and silvery white, the narrow darker rings occupying the central and apical portions of the individual segments; lateral borders of tergites and posterior portions of intermediate sternites variegated with silvery white areas; outer tergites and genital shield chiefly blackened. Cerci elongate.

Habitat.—Formosa.

Holotype, female, Kanshirei, altitude 1,500 feet, May 13, 1933 (*Issiki*).

I take great pleasure in naming this fine species in honor of the collector of this series of Tipulidæ, my friend, Prof. Syûti Issiki. The species is of great interest in being the first true member of the subgenus *Dolichopeza* to be discovered in continental Asia or the Indo-Malayan islands. The subgeneric position of *Dolichopeza postica* Brunetti is still questionable, but from the rather remarkable venation of the medial field of the wing it does not seem to be strictly referable to the subgenus *Dolichopeza*. Similarly the three Philippine members of the *malagasya* group (*ata* Alexander, *isolata* Alexander, and *bilan* Alexander) are by no means typical members of the subgenus, though placed therein provisionally. The present fly bears a superficial resemblance to *D.* (*Nesopeza*) *albitibia* Alexander, but the subgeneric characters will readily serve to distinguish the two.

DOLICHOPEZA (MITOPEZA) TAIWANICOLA sp. nov. Plate 1, fig. 4.

General coloration of mesonotum dark brown, with four paler brown stripes; knobs of halteres at tips conspicuously yellow;

tibiæ and tarsi uniformly black; wings rather strongly tinged with brown, the stigma darker; restricted cream-colored areas before and beyond stigma and across base of cell 1st M_2; sparse macrotrichia in distal ends of outer radial and medial cells; Sc_2 ending opposite origin of the short Rs; R_{1+2} represented as a short spur; cell M_1 long-petiolate; cell 1st M_2 very small, lying in fork of veins M_{1+2} and M_3; m-cu more than one-half its length before fork of M; abdominal tergites brown, the caudal borders narrowly blackened.

Female.—Length, about 8.5 millimeters; wing, 11.2.

Frontal prolongation of head testaceous-yellow; region of nasus tufted with three or four long black setæ; palpi black. Antennæ with scape and pedicel light yellow; flagellum brownish black, the flagellar verticils approximately equal in length to the segments. Front light yellow, the vertex brown; anterior vertex approximately five times as wide as diameter of scape.

Ground color of mesonotal præscutum dark brown, with four paler brown stripes, the intermediate pair narrow, tapering behind, separated by a dark median gray line that is nearly equal in width to the stripes; posterior sclerites of notum dark brown. Pleura obscure brownish yellow, the propleura and anepisternum darker brown; dorsopleural membrane extensive, dark brown. Halteres pale yellow, the bases of knobs brownish black, the apices broadly and conspicuously light yellow. Legs with the coxæ dark brown; trochanters testaceous-brown; femora dark brown, the tips passing into black; tibiæ and tarsi black; legs of moderate length only. Wings (Plate 1, fig. 4) with a rather strong brown tinge, cells C and Sc very slightly darker; stigma oval, dark brown; restricted but conspicuous cream-colored areas before and beyond stigma and across the base of cell 1st M_2; wing tip as far back as vein Cu_1 narrowly darkened; Cu, 2d A, and most of the longitudinal veins beyond cord very narrowly and insensibly seamed with darker; veins brownish black. Sparse macrotrichia in outer ends of cells Sc_2+R_2, R_3, R_5, M_1, and 2d M_2. Venation: Sc_2 ending opposite origin of the short Rs; R_1 meeting R_2 at an angle, with R_{1+2} projecting beyond this point as a short spur; cell 1st M_2 very small, a little widened outwardly; petiole of cell M_1 elongate, subequal to m-cu; m-cu more than one-half its length before fork of M, M_4 branching off some distance before base of cell 1st M_2.

Abdominal tergites brown, the caudal borders of the segments narrowly blackened; sternites obscure yellow, the caudal borders narrowly darkened. Ovipositor with small blunt valves, as in subgenus.

Habitat.—Southern Formosa.

Holotype, female, Keinensan, altitude 5,400 feet, August 14, 1933 (*Issiki*).

Dolichopeza (*Mitopeza*) *taiwanicola* is very different from the other described members of the subgenus in the short, oblique Rs, with Sc_2 ending opposite its origin. By my key to the subgenera of *Dolichopeza*[4] the species runs to couplet 3, including *Mitopeza*, but disagrees in the character of the short sector. By my further key to the species of *Mitopeza*,[5] the present fly runs to the subgenotype, *nitidirostris* (Edwards), a very different insect whose wing has been figured by Edwards.[6] The latter fly has the long Sc and Rs, together with cell 1st M_2 large and cell M_1 entirely sessile. The subgenus is new to the fauna of Formosa and the Japanese Empire.

TIPULA (TRICHOTIPULA) HAPLOTRICHA sp. nov. Plate 1, fig. 5; Plate 2, fig. 26.

General coloration black, including the entire thorax, the pleura slightly pruinose; antennæ black, moderately long (male); legs black; wings with a strong brownish yellow tinge; stigma oval, dark brown; abundant macrotrichia in cells beyond cord, with the exception of 1st M_2; M_{3+4} shorter than r-m; m-cu elongate and very oblique in position; male hypopygium with caudal margin of tergite having a broad U-shaped notch; inner dististyle with the apical beak very long and slender; ninth sternite on either side produced into a pale fleshy lobe.

Male.—Length, about 11 millimeters; wing, 12; antenna, about 4.

Rostrum and palpi black. Antennæ black, the apex of pedicel a trifle paler; flagellar segments with basal enlargements very slightly developed, the verticils scarcely one-half the length of the segments, on the outer segments becoming even shorter; terminal segment reduced to a small berrylike structure. Head gray, clearer light gray on front and anterior vertex, the latter very wide.

[4] Philip. Journ. Sci. 46 (1931) 270.

[5] Tome cit. 272.

[6] Journ. Fed. Malay St. Mus. 14 (1928) pl. 1, fig. 20.

Pronotum and mesonotum entirely coal black, polished. Pleura black, the surface sparsely pruinose; dorsopleural membrane dark brown. Halteres long, the stem obscure yellow, the knob dusky. Legs with the coxæ blackened; trochanters yellow; remainder of legs black, the femoral bases rather narrowly obscure yellow. Wings (Plate 1, fig. 5) with a strong brownish yellow tinge; stigma oval, dark brown; obliterative areas before stigma and across base of cell 1st M_2; veins light brown. Abundant macrotrichia in cells beyond cord, with the exception of 1st M_2, in cells M_3 to 1st A becoming progressively fewer and more nearly restricted to vicinity of margin. Venation: R_{1+2} preserved; petiole of cell M_1 shorter than m; M_{3+4} shorter than r-m; basal section of M_4 perpendicular; m-cu elongate and very oblique, somewhat as in the subgenus *Schummelia*, cell M_4 thus markedly widened at base.

Abdominal tergites black, the basal sternites more brownish; hypopygium black. Male hypopygium (Plate 2, fig. 26) relatively small, the tergite completely separated from the sternite, 9*s;* basistyle delimited by straight sutures, the cephalic portion fused with the sternite. Ninth tergite, 9*t*, with caudal margin produced into two flattened, dark-colored lobes, glabrous, their apices obliquely truncated; notch between lobes broadly U-shaped; dorsal surface of tergite with abundant setæ, these lacking only on the narrow median area and on the posterior border. Outer dististyle, *od*, a small oval spatulate lobe, with numerous setæ. Inner dististyle, *id*, blackened, produced into a long slender black beak, with a shorter black lobe lying more basad, the two together roughly resembling an irregular pair of pincers. Ninth sternite, 9*s*, behind on either side produced into a pale fleshy lobe, provided with numerous long setæ. Eighth sternite unarmed.

Habitat.—Formosa.

Holotype, male, Kanshirei, altitude 1,500 feet, May 13, 1933 (*S. Issiki*).

Tipula (*Trichotipula*) *haplotricha* is a true member of the subgenus, the first to be reported from Japan or Formosa. The fly requires comparison with no other Japanese species of the genus having macrotrichia in the outer cells of the wing. From other species of the subgenus, it is readily told by the polished black mesonotum and the rich brownish yellow coloration of the wings. The degree of trichiation of the wings is much less than in *T.* (*T.*) *polytrichia* Alexander (western China).

TIPULA (VESTIPLEX) NESTOR sp. nov. Plate 1, fig. 6; Plate 2, fig. 27.

Belongs to the *himalayensis* group; mesonotal præscutum dark gray, with four broad dark brown stripes; antennal scape and pedicel light yellow, flagellum black; femora yellow, before midlength passing into brown, the tips conspicuously blackened, preceded by a clear yellow ring; wings yellowish subhyaline, with pale and darker brown areas; basal five abdominal segments chiefly yellow, with ill-defined markings, the outer segments uniformly blackened; male hypopygium with caudal margin of ninth tergite with a very broad V-shaped notch, the lateral lobes thus formed slender and pale; basistyle obtuse at tip.

Male.—Length, about 14 millimeters; wing, 18.5.

Frontal prolongation of head ocherous above, dark brown laterally beneath; nasus elongate, brownish black; palpi black. Antennæ of moderate length; scape and pedicel yellow, flagellum black throughout; verticils subequal to or a trifle longer than the segments. Head brownish yellow, with a narrow brown longitudinal stripe extending from the summit of anterior vertex to shortly before occipital band.

Mesonotal præscutum somewhat discolored, the ground color dark gray, with four broad dark brown stripes, the intermediate pair barely separated by a capillary gray vitta, their mesal edges narrowly blackish; lateral borders more ocherous; scutum dark gray, each lobe with two confluent dark brown stripes; scutellum and mediotergite dark gray, with a more or less distinct median dark vitta. Pleura with anepisternum and sternopleurite chiefly darkened and pruinose; posterior sclerites and pleurotergite much paler, more ocherous. Halteres with stem obscure brownish yellow, knobs dark brown with pale apices. Legs with the coxæ and trochanters chiefly pale; femora yellow basally, before midlength passing into brown, the tips conspicuously blackened, preceded by a clearer yellow subterminal ring; tibiæ brownish black, the tips narrowly blackened; tarsi black. Wings (Plate 1, fig. 6) with the usual pattern of the group; postarcular brown area conspicuous and clearly delimited; cream-colored areas in outer ends of anal cells restricted in size but well-defined; whitish spot before stigma entirely surrounded by brown. Venation: R_4 long and gently sinuous, cell R_2 at margin considerably more extensive than cell R_4; inner end of cell 1st M_2 pointed; m-cu close to fork of M_{3+4}.

Abdomen with basal five tergites yellow, with very ill-defined dusky median and sublateral stripes, on basal three or four seg-

ments unusually narrow, on the fifth segment the laterals much heavier; sixth tergite black except for a restricted obscure yellow area on either side of median line; succeeding segments and hypopygium black; basal five sternites uniformly yellow, the outer four black. Male hypopygium (Plate 2, fig. 27) with the tergite separated from sternite except on cephalic portion; basistyle well delimited by a pale suture above, the apex obtuse, not or scarcely produced. Ninth tergite, *9t*, relatively short, the caudal margin with a very broad V-shaped notch, the very slender lateral lobes paler than the remainder of sclerite, fringed with long pale setæ; on ventral surface of sclerite on either side and separated by pale membrane is a slender black chitinized point, not shown in figure. Mesal or inner face of basistyle, *b*, with a flattened ribbonlike blade, with five or six setæ near apex. Outer dististyle, *od*, a spatulate blade. Inner dististyle, *id*, narrowed at apex into a blackened beak. Eighth sternite with margin gently and convexly rounded, unarmed; pale medially at margin; a broken transverse row of pale spots or punctures near base of sclerite.

Habitat.—Formosa.

Holotype, male, Kanzangoe, Taitô-chô Kaimosu to Kanzanan-bu, August 19, 1932 (*Esaki*).

There are now several species in Formosa that appear to belong to the *himalayensis* group of *Vestiplex*, such including *arisanensis* Edwards, *bicornuta* Alexander, *biserra* Edwards, *foliacea* Alexander, *terebrata* Edwards, and probably *quadrifulva* Edwards. Several of these are still known only from the female sex. The present fly differs notably from all other species in which the male sex is known in the structure of the hypopygium. Among the other species, it agrees most nearly with *terebrata* Edwards (Formosa, in May), differing especially in the details of coloration of the head, thorax, and abdomen, and in the finer points of wing pattern. Edwards's figure of the wing of *terebrata*[1] shows the costal and subcostal cells to be much darker than in the present species, the pale areas in anal field more extensive and diffuse, and with the basal section of vein M_3 longer than the basal section of M_{1+2}. The discovery of the male sex of *terebrata* will probably show points of difference in the hypopygium.

[1] Ann. & Mag. Nat. Hist. IX 8 (1921) pl. 10, fig. 16.

TIPULA (VESTIPLEX) PARVAPICULATA sp. nov. Plate 1, fig. 7; Plate 2, figs. 28, 29.

Belongs to the *himalayensis* group; mesonotal præscutum olive-gray, with four narrow grayish brown stripes that are slightly margined with darker brown; antennal flagellum weakly bicolorous; apices of knobs of halteres conspicuously whitish; femora yellowish brown, the tips blackened, preceded by a clearer yellow ring; wings light brown, variegated with darker brown and cream-colored areas as in the group; cell R_3 at margin a little more extensive than cell R_4; basal abdominal tergites reddish yellow, trivittate with brownish black; outer four segments uniformly brownish black; male hypopygium with caudal margin of tergite broadly emarginate; basistyle obtuse at tip but produced into a small acute black spine; a long slender arm from mesal face of basistyle is bifid at tip into two acute spines.

Male.—Length, about 15 millimeters; wing, 18.5.

Frontal prolongation of head ocherous above, darker laterally beneath. Antennæ of moderate length only; basal three segments pale; succeeding segments weakly bicolorous, the basal enlargements black, the outer portions brown, only the outer segments becoming uniformly darkened. Head olive-gray, with a conspicuous brown line on posterior vertex, this sending a capillary vitta onto summit of vertical tubercle, the line being further produced behind to the occiput.

Mesonotal præscutum olive-gray, with four narrow grayish brown stripes that are slightly margined with dark brown, the ground color most distinct on cephalic ends of the intermediate stripes; scutal lobes similar, each with two clearly separated dark brown areas; posterior sclerites of mesonotum gray, with a conspicuous median brown line. Pleura chiefly olive-gray, variegated by darker areas, especially on ventral anepisternum, ventral sternopleurite and on posterior sclerites, the pleurotergite with a ridge of the ground color. Halteres dusky, the base of stem restrictedly pale; base of knob dark brown, the apex of same conspicuously pale. Legs with coxæ olive-gray; trochanters yellow; femora chiefly light yellowish brown, the tips blackened, preceded by a clearer yellow ring; tibiæ dark brown, the tips narrowly blackened; tarsi black. Wings (Plate 1, fig. 7) light brown, variegated by darker brown and cream-colored areas, as in the group; postarcular darkening in cells R and M extensive and clearly defined; cream-colored area immediately before origin of Rs extensive; pale spot before stigma barely confluent with the pale color in cell R_1; outer cream-colored area in cell

M much restricted in area; pale areas in outer ends of anal cells very small and ill-defined; veins brown, paler in the flavous costal region. Venation: Cell R_3 at margin a little more extensive than cell R_4.

Abdomen with the basal four tergites chiefly reddish yellow, trilineate with brownish black, the lateral borders beyond the base broadly grayish; tergite five more darkened apically; outer four segments uniformly brownish black. Male hypopygium (Plate 2, fig. 28) with the tergite, 9*t*, fused basally with the sternite; basistyle, *b*, cut off from sternite by broad and deep dorsal, and narrow, less distinct, ventral sutures, the narrow central portion being fused, without sutures. Ninth tergite, 9*t*, with the dorsal surface pale, with a more-blackened central band that is narrowly interrupted at the midline; caudal margin of tergite broadly emarginate, the lateral lobes wide but thin; a small median denticle; from ventral surface of tergite on either side a black flattened plate, its margin microscopically serrulate. Basistyle (Plate 2, fig. 29, *b*) with the broadly obtuse apex further produced into a tiny black apiculate point, the ventromesal portions further produced mesad into slender arms that are blackened and curved into weak spines at tips, not widely separated at the midline of body; a conspicuous arm of basistyle, *b*, is produced caudad as a slender rod, at apex divided into two acute spines, one subapical and smaller than the axial spine; lower margin of this sclerotized arm with a sparse fringe of long erect yellow setæ distributed the entire length of the structure. Dististyles, *id*, *od*, as shown. Ninth sternite with a median membranous U-shaped incision. Eighth sternite unarmed but with an interrupted transverse row of pale punctures on basal half.

Habitat.—Northern Formosa.

Holotype, male, Taiheizan, Taihoku-shû, October 24, 1932 (*Keishô Satô*).

Tipula (*Vestiplex*) *parvapiculata* is still another of the now numerous species of the *himalayensis* group in Formosa. All such species are most readily and safely classified by the details of structure of the male hypopygium. On such a character, the present fly is told by the small apiculate black point at apex of the basistyle. Compared with the Formosan species of the group that were described by Edwards, the fly agrees most nearly with *T.* (*V.*) *biserra* Edwards in the bicolorous antennal flagellum, differing most evidently in the pattern of the legs and wings

and in the venation, especially of the outer radial field, where vein R_3 is not deflected cephalad at its outer end, thus narrowing cell R_2. It cannot be stated whether these now rather numerous species of the group are definitely seasonal in distribution, as is the case with most holarctic species of the genus. The present fly is on the wing in autumn, whereas all of Edwards's species (*arisanensis, biserra, quadrifulva,* and *terebrata*) are adult in April and May. It is questionable, further, whether *quadrifulva* belongs to the subgenus *Acutipula* or to *Vestiplex;* the wing pattern is much as in members of the *himalayensis* group of *Vestiplex,* but the brief description of the ninth tergite of the male hypopygium is very suggestive of the condition found in *Acutipula.*

TIPULA (ACUTIPULA) OBTUSILOBA sp. nov. Plate 2, fig. 30.

Belongs to the *munda* group; allied to *oncerodes,* differing chiefly in the structure of the male hypopygium, especially of the inner dististyle, the outer lobe of which is obtusely rounded and unarmed except for a small acute spine on the outer margin at near midlength.

Male.—Length, about 19 to 21 millimeters; wing, 24 to 26.

Frontal prolongation of head obscure yellow, the elongate nasus brown; palpi dark brown. Antennæ short, not exceeding the head in length; scape and pedicel yellow; flagellum bicolorous, the bases of the segments weakly darkened, the apices yellow, the outer segments more uniformly darkened; verticils much longer than the segments. Head dark brown, probably pruinose in fresh specimens, discolored in types.

Mesonotum almost uniformly brown, without distinct markings; mediotergite darker, with conspicuous yellow setæ. Pleura more yellowish, paler than the notum. Halteres slender, obscure yellow, the knobs darker. Legs yellowish brown to brown, elongate. Wings grayish subhyaline, cells C and Sc, with the stigma more yellowish brown; veins slightly darker brown. Venation: Second section of M_{1+2} rather strongly arcuated; petiole of cell M_1 a little longer than m.

Abdominal tergites rather light brown, the outer segments somewhat darker; sternites more brownish yellow. Male hypopygium with the median lobe of tergite as viewed from above (Plate 2, fig. 30, 9*t*) slender, with conspicuous black spinous points at tip and for a short distance basad. Outer dististyle flattened, entirely pale. Inner dististyle, *id,* with the apical beak pale, only the margin blackened, relatively stout; outer lobe

with apex obtusely rounded, unarmed except for a single acute spinous point on outer or posterior margin at near midlength of lobe.

Habitat.—Northern Formosa.

Holotype, male, Taiheizan, Taihoku-shû, Kamiyodani, July 25, 1932 (*Esaki*). Paratopotype, male.

Tipula (*Acutipula*) *obtusiloba* is most nearly allied to *T.* (*A.*) *oncerodes* Alexander and *T.* (*A.*) *platycantha* Alexander, of western China, differing in the structure of the hypopygium, more especially of the inner dististyle. The beaklike portion of the style is much stouter than in *platycantha*, while the armature of the outer lobe is quite different in all three species. The species of *Acutipula* from Japan proper, with the wings unmarked, including *T.* (*A.*) *bipenicillata* Alexander and *T.* (*A.*) *tokionis* Alexander, have the hypopygium of very different structure.

TIPULA (OREOMYZA) KOREANA sp. nov., Plate 1, fig. 8; Plate 2, fig. 31.

Belongs to the *marmorata* (*fragilis*) group; scape and pedicel yellow, flagellum black; femora yellow, the tips conspicuously brownish black; wings gray, variegated by dark brown and cream-colored areas as in the group; a dark cloud at outer end of cell R_2 and adjoining parts of R_3; cells Sc and Cu_1 uniformly darkened; male hypopygium with the tergite produced into two divergent points; inner dististyle black, gradually narrowed into a long slender apical point; eighth sternite projecting, narrowed outwardly, the slender obtuse apex densely clothed with abundant short yellow setæ.

Male.—Length, about 13 millimeters; wing, 15.

Female.—Length, about 17 to 20 millimeters; wing, 15.5 to 18.

Frontal prolongation of head gray; nasus elongate; palpi dark brown. Antennæ with scape and pedicel yellow; flagellum black; flagellar segments (male) rather strongly incised for a member of this group, the longest verticils subequal to the segments. Head gray.

Pronotum gray. Mesonotum light gray, the præscutum with four bright brown stripes, the intermediate pair not attaining the suture behind and each split at anterior ends, the outer margin extended a slight distance cephalad beyond the internal border; scutal lobes variegated with brown. Pleura gray, the dorsopleural membrane buffy brown. Halteres yellow, the knobs dark

brown. Legs with the coxæ gray; trochanters yellow; femora yellow, the tips conspicuously brownish black; tibiæ obscure yellow, the tips brownish black; tarsi black, the proximal ends of basitarsi more brightened. Wings (Plate 1, fig. 8) with the ground color gray, variegated by dark brown and cream-colored areas; stigma and cells Sc and Cu_1 uniformly brown; prearcular region light yellow, cell C brownish yellow; restricted brown seams along anterior cord, at origin of Rs, outer end of cell R_2, and adjoining central portion of cell R_3; wing margin narrowly seamed with brown; paler brown clouds in cells M, Cu, and anals as in group; veins brown. Crossveins m and m-cu with complete series of macrotrichia. Venation: Sc_2 ending opposite midlength of the relatively long Rs; m-cu not far beyond inner end of cell 1st M_2, M_{3+4} being short to very short; m-cu on M_4 shortly beyond base; veins R_3, second section of M_{1+2}, M_1 and M_2 all arcuated, as common in group.

Abdomen with basal tergite brownish gray; segments two and three, together with base of four, light yellow, the outer segments more uniformly brownish gray. In female, the subbasal tergites are more or less distinctly bordered laterally by darker. Male hypopygium (Plate 2, fig. 31) with the tergite, 9*t*, fused with sternite except for a distal suture; basistyle chiefly fused with sternite. Ninth tergite, 9*t*, with the caudal margin produced into two blackened, decurved, and slightly divergent points; apical margin on ventral surface slightly more tumid and set with small blackened points. Outer dististyle, *od*, flattened, the dorsal margin at base heavily blackened but not produced into a tooth as in several species of the group. Inner dististyle, *id*, almost uniformly blackened, narrowed at apex into a long slender black spine, with a small fleshy lobule on each side at base; face of style on posterior portion near base produced into a long acute black spine. Basistyle not produced but its inner or ventral margin heavily blackened and produced into a small black spine, shown in figure. Eighth sternite, 8*s*, long, produced into a shovellike lobe, narrowed outwardly, the tip fringed with abundant short yellow setæ; sclerite brown, with a conspicuous yellow median midline.

Habitat.—Korea.

Holotype, male, Kongo San, October 8, 1933 (*Machida*). Allotopotype, female, October 17, 1933. Paratopotypes, 3 females, October 8 to 18, 1933 (*Machida*).

I consider the present fly to be somewhat more nearly allied to *Tipula (Oreomyza) kiushiuensis* Alexander, of southern Japan, than to the various Siberian species (*cupida* Alexander, *docilis* Alexander, *fidelis* Alexander). However, it is very distinct from all in hypopygial characters, notably of the inner dististyle and eighth sternite.

TIPULA (OREOMYZA) OBNATA sp. nov. Plate 1, fig. 9; Plate 2, fig. 32.

General coloration gray, with a continuous brown median vitta extending from vertex of head to base of abdomen; præscutal interspaces with numerous dark punctures; legs black; wings whitish, the costal region more yellowish; cell Sc before arculus darkened; several of the longitudinal veins narrowly but conspicuously seamed with black; R_{1+2} chiefly atrophied; basal abdominal tergites yellow, narrowly trivittate with brown; outer segments more uniformly brownish black; male hypopygium with the median region of tergite with a broad median notch; apex of eighth sternite with abundant setæ.

Male.—Length, about 9.5 millimeters; wing, 11.

Female.—Length, 12 to 13 millimeters; wing, 12 to 13.5.

Frontal prolongation of head light gray above, dark below and on sides; palpi black. Antennæ, if bent backward, extending to beyond the wing root; scape, pedicel, and basal segment of flagellum yellow; succeeding flagellar segments weakly bicolorous, the basal enlargements black, the remainder dark brown; verticils shorter than the segments. Head light gray, with a very delicate capillary dark median vitta.

Mesonotum gray, with a continuous median brown vitta extending from cephalic portion of præscutum to base of abdomen, scarcely or but slightly interrupted at the various sutures; præscutal stripes four, only insensibly darker gray than the ground; interspaces with conspicuous brown setigerous punctures; scutal lobes conspicuously variegated with dark brown. Pleura light gray, the dorsopleural region pale yellow. Halteres with stem pale, the knobs darkened. Legs with the coxæ yellow, sparsely pruinose; trochanters yellow; remainder of legs black, femora scarcely brightened basally; in allotype, the posterior femora show very vague indications of a subterminal obscure yellow ring. Wings (Plate 1, fig. 9) with the ground color whitish, the posterior prearcular region and cell Sc clear light yellow, cell C a trifle more brownish yellow; anterior prearcular region, especially in cell Sc, conspicuously dark brown; a re-

stricted dark brown pattern, including the stigma, cord, vein Cu, including cell Cu_1, a slight postarcular darkening and narrow dark seams on veins R_{4+5}, outer half of M, all branches of M, and all of 2d A except the very narrow basal portion; a much paler brown clouding in outer radial cells; vein 1st A not seamed with brown; veins dark, more flavous in the yellow areas described. Venation: R_{1+2} persisting only as a short basal spur; cell M_1 large; cell 1st M_2 relatively small.

Abdomen with basal four or five segments yellow, the tergites narrowly trivittate with brown; midline of sternum similarly darkened; outer segments more uniformly brownish black. Male hypopygium (Plate 2, fig. 32) with the tergite, 9*t*, separate from the sternite, 9*s*; basistyle chiefly delimited from sternite. Ninth tergite, 9*t*, with a broad median notch, the dorsal face with a median incised line. Outer dististyle, *od*, pale, dilated outwardly, the apex obliquely truncated. Inner dististyle, *id*, with a row of about fifteen to eighteen slender setæ on outer margin but without a blackened basal spine, as in *edwardsella*. Eighth sternite, 8*s*, large and sheathing, the slope of its obtuse outer end with abundant setæ; in membrane between the eighth and ninth sternites, on midline of body, a further brush of long setæ. Ædeagus relatively short and stout.

Habitat.—Formosa.

Holotype, male, Hassenzan, Taichu-shû, Reimei, July 13, 1932 (*Esaki*). Allotopotype, female, Reimei-Piawaikei-Baibarasan, July 13, 1932 (*Esaki*). Paratype, female, Taiheizan, Taihoku-shû, Toganoo, July 21, 1932 (*Esaki*).

The nearest ally of the present fly seems undoubtedly to be *Tipula* (*Oreomyza*) *edwardsella* Alexander (*flavicosta* Edwards, preoccupied), likewise from the high mountains of Formosa, on the wing in May. This fly lacks the median dark vitta on the posterior sclerites of the mesonotum, as also the dark punctures on the præscutal interspaces. The details of the wing pattern, venation, halteres, coloration of abdomen, and structure of the male hypopygium, are likewise distinct. The larger *Tipula pluriguttata* Alexander similarly has the atrophied vein R_{1+2} and conspicuous setigerous punctures on the præscutal interspaces, but is entirely different in coloration of the body and wings; its male is still unknown to me.

LIMONIINÆ

LIMONIINI

LIMONIA (LIMONIA) MELAS sp nov. Plate 1, fig. 10; Plate 3, fig. 33.

Belongs to the *globithoracx* group; general coloration of entire body dark brown or brownish black; antennæ black throughout, basal flagellar segments globular; halteres and legs black; wings very strongly suffused with blackish; male hypopygium with the tergite deeply notched medially, each lobe conspicuously produced; rostral spines at extreme base of outer face of dististyle, the apex of the latter gently emarginate and set with powerful setæ; a small black point some distance before apical spine of gonapophysis.

Male.—Length, about 4.5 millimeters; wing, 5.5.

Rostrum and palpi black. Antennæ black throughout; basal flagellar segments globular, the outer ones passing into short-oval; terminal segment slenderer but scarcely longer than the penultimate. Head brownish black; anterior vertex a little brightened, a trifle wider than the diameter of the scape.

Pronotum and mesonotum dull dark brown or brownish black; setæ on anterior interspaces long and conspicuous; scutellum a little paler. Mesonotum high and gibbous, as in the group. Pleura dark brown. Halteres black throughout. Legs with the coxæ dark brown; trochanters testaceous; remainder of legs black. Wings (Plate 1, fig. 10) very strongly suffused with blackish; cells C and Sc a trifle darker, prearcular cells a little paler; veins black. Venation: Sc_1 ending beyond midlength of Rs, Sc_2 at its tip; free tip of Sc_2 pale, more than its own length before level of R_2, the intervening section of vein R_1 with about five trichia; m-cu at fork of M.

Abdomen, including hypopygium, black. Male hypopygium (Plate 3, fig. 33) with the tergite, *9t*, deeply notched medially, each lobe conspicuously produced. Dististyle, *d*, with the rostral spines at extreme base on outer margin, as in the group; style flattened, very gently widened outwardly, the apex very slightly emarginate and fringed with abundant strong powerful setæ; other more delicate setæ on outer and inner margins of style but none on disk. Gonapophyses, *g*, with mesal-apical lobe produced into a long curved black spine, with a further small blackened point as base of the narrowed portion. Entire surface of ædeagus, *a*, covered with abundant delicate setulæ.

Habitat.—Southern Formosa.

Holotype, male, Keinensan, altitude 5,400 feet, August 14, 1933 (*Issiki*).

The nearest allies of the present fly are *Limonia* (*Limonia*) *globithorax* (Osten Sacken) of northeastern North America, and its very close vicarious representative, *L.* (*L.*) *globulithorax* (Alexander), of northern Japan. The present species is readily told from these by differences in the structure of the male hypopygium, especially of the tergite, dististyles, and gonapophyses.

It may be doubted that the two pale spines placed at the extreme base of the outer face of the dististyle are really homologous with the rostral spines found elsewhere throughout the genus, and it seems advisable at this time to point out a few of the intermediate stages that have culminated in this peculiar condition. Normally the spines are one, or more often two, in number and are placed on a lobe or produced area on the mesal face of the dististyle, commonly called the rostrum or rostral prolongation; when two dististyles are present, this rostral production is on the ventral style. The vast majority of all species in the genus (and including representatives of every one of the known subgenera of *Limonia;* namely, *Alexandriaria, Dapanoptera, Dicranomyia, Discobola, Doaneomyia, Euglochina, Geranomyia, Goniodineura, Idioglochina, Laosa, Libnotes, Limonia, Neolimnobia, Peripheroptera, Pseudoglochina, Rhipidia, Thrypticomyia, Zalusa,* and *Zelandoglochina* [8]) have one or both of these spines present and placed on the rostral prolongation itself, usually at or beyond midlength, more rarely at or close to base of the prolongation. In a few cases (attaining an extreme in certain species of *Dicranomyia* and *Rhipidia*) the rostral spines may reach the number of a dozen or more, all placed on the prolongation. From this start we then find species where both spines are definitely removed from the prolongation onto the face of the style. Further progressive modifications move the spines caudad and thence cephalad around the periphery of the style, they being at the exact summit in *L.* (*Discobola*) *margarita* Alexander; beyond the summit and far distad on outer face of style in *L.* (*Limonia*) *flavoterminalis* Alexander; halfway between this point and the base on outer face in *L.* (*Limonia*) *tabashii* sp. nov. (Plate 3, fig. 34), and close to the extreme base in the present species (Plate 3, fig. 33), *L.* (*Limonia*) *globithorax* Osten Sacken, and several others of this general

[8] Vide Alexander, Philip. Journ. Sci. 40 (1929) 241–244.

group. Thus in the Japanese fauna alone we have almost every possible position of the rostral spines on the periphery of the ventral dististyle. In other faunal regions, other curious deviations from the normal position may be found, as in *Limonia* (*Limonia*) *firestonei* Alexander and *L.* (*L.*) *metatarsalba* Alexander, of the Ethiopian Region, where the spines lie on the disk of the style. I have been somewhat detailed and specific in the above statement as I desire to show that even in as plastic a character as the position of these spines all subgeneric groups show this fundamental character and show close interrelationships. Certain students of the Tipulidæ still maintain *Limonia* as being distinct from *Dicranomyia*, *Geranomyia*, and other familiar groups in this complex, believing that the hypopygium of *Limonia* has a construction very different from that of the other mentioned groups. That this belief has no basis in fact becomes readily apparent when one studies a considerable range of types throughout the genus.

LIMONIA (LIMONIA) TABASHII sp. nov. Plate 1, fig. 11; Plate 3, fig. 34.

Belongs to the *globithorax* group; antennæ black throughout; mesonotum only slightly gibbous, fulvous to orange, the pleura pale yellow; legs and halteres chiefly darkened; wings uniformly tinged with brown; stigma lacking; Sc relatively short, ending just beyond one-third the length of Rs; abdominal tergites dark brown, the basal sternites and hypopygium yellow; male hypopygium with the dististyle narrowed to the rostral portion, at apex with a blackened spine; rostral spines lying on outer face of style at about one-third the distance from base.

Male.—Length, about 4 to 4.2 millimeters; wing, 4.8 to 5.

Rostrum and palpi reduced in size, dark. Antennæ black throughout; flagellar segments subglobular, the outer ones slightly more elongate; terminal segment strongly constricted and narrowed beyond midlength; longest verticils unilaterally arranged and exceeding the segments in length. Head light fulvous.

Mesonotum only slightly gibbous, light fulvous to orange, the scutellum a little more obscure. Pleura pale yellow. Halteres brown, the stem obscure yellow. Legs with the coxæ and trochanters pale yellow; femora obscure yellow, the tips weakly darkened; tibiæ dark brown; tarsi black. Wings (Plate 1, fig. 11) uniformly tinged with brown; stigma lacking; veins darker brown. Venation: Sc relatively short, Sc_1 ending at just beyond one-third the length of Rs, Sc_2 at its tip; free tip of Sc_2

lying opposite or just before level of R_2; m-cu at fork of M, subequal to distal section of Cu_1.

Abdominal tergites dark brown; basal sternites yellow, the outer ones somewhat darker; hypopygium yellow. Male hypopygium (Plate 3, fig. 34) with the tergite, 9*t*, large, narrowed outwardly, the caudal margin with a U-shaped notch, the obtuse lateral lobes with long conspicuous setæ. Basistyle, *b*, relatively slender, the ventromesal lobe at outer end. Dististyle, *d*, fleshy, much smaller than the basistyle, oval, the rostral portion more narrowed and terminating in an acute blackened spine; rostral spines two, migrated to the outer face of style at about one-third the distance from base. Gonapophyses, *g*, with mesal-apical lobe long and slender, nearly straight. Ædeagus, *a*, broad, the central portion profoundly bifid.

Habitat.—Korea.

Holotype, male, Suigen, September 16, 1930 (*Tabashi*); No. 28. Paratopotype, male.

Limonia (*Limonia*) *tabashii* is named in honor of the collector of this interesting material. The species needs no comparison with other members of the group, being readily told by the fulvous mesonotum and structure of the male hypopygium, especially of the dististyle and the position thereon of the rostral spines.

LIMONIA (LIBNOTES) BASISTRIGATA sp. nov. Plate 1, fig. 12.

Coloration of entire thorax and abdomen pale yellow; antennal flagellum yellow, the narrowed outer half of the terminal segment black; knobs of halteres brownish black; legs yellow, the tips of femora and tibiæ broadly black; vestiture of femora consisting of very small spinous setæ; wings yellow, sparsely variegated with dark brown; a conspicuous black streak between wing base and crossvein *h*, occupying cells C and Sc; setæ of costal fringe short; ovipositor with cerci bifid at tips.

Male.—Length, about 13 to 15 millimeters; wing, 19 to 21.

Female.—Length, about 15 millimeters; wing, 19.

Rostrum dark brown; palpi black. Antennæ with scape brown; pedicel and antennæ light yellow, the apical half of last segment suddenly blackened; flagellar segments subglobular to short-oval, with verticils that are shorter (on basal segments) to a little longer than the segments; terminal segment longer and suddenly narrowed on distal end. Head gray, the posterior vertex chiefly suffused with rich brown; anterior vertex narrow, about one-third the diameter of scape.

Pronotum, mesonotum, and pleura entirely pale yellow, unmarked. Halteres yellow, the knobs brownish black. Legs with the coxæ and trochanters light yellow; femora yellow, the tips broadly and conspicuously blackened; tibiæ yellow, the tips a little more narrowly blackened; basitarsus and second segment brownish yellow, the tips narrowly blackened; outer three tarsal segments more uniformly blackened; vestiture of legs consisting of abundant but very small spinous setæ, on tarsi somewhat longer and more appressed. Wings (Plate 1, fig. 12) strongly tinged with pale yellow, the costal border to apex clearer bright yellow; a conspicuous black streak extends from wing base to *h* in cells C and Sc; restricted dark brown seams at origin of Rs, along cord, Sc_2, free tip of Sc_2, and R_2; outer end of cell 1st M_2; a continuous dark seam on outer half of basal section of Cu_1 and the entire distal section of the same vein; vein R_{4+5} more narrowly seamed with brown, its base and apex clear; outer half of vein 2d A seamed with brown; extreme axillary region darkened; veins yellow, brown in the infuscated areas. Setæ of costal fringe abundant but very short; trichia of veins small and delicate. Venation: Free tip of Sc_2 and R_2 in approximate transverse alignment; R_3 and R_4 parallel on outer ends and very strongly decurved; m about twice the basal section of M_3; m-cu a little more than its own length beyond the fork of M; anal veins convergent basally.

Abdomen, including hypopygium, entirely light yellow. Male hypopygium of the usual structure of the subgenus; lobe of ventral dististyle with four or five long powerful setæ; spines of rostral prolongation elongate, nearly as long as the prolongation itself, arising close together from a short common tubercle, one spine slightly lower than the other. Ovipositor with cerci bifid at tips.

Habitat.—Korea.

Holotype, male, Kongo San, October 16, 1933 (*Machida*). Allotopotype, female, October 17, 1933. Paratopotype, male, with the allotype.

The nearest allied species is *Limonia* (*Libnotes*) *nohirai* (Alexander), of Korea and northern Japan, which differs conspicuously in the dark brownish gray coloration of the mesonotum and pleura, the differently patterned wings, such as the lack of the black basal streak, the differently patterned abdomen, and other characters. The two species are evidently allied, agreeing in the

general pattern of the wings and legs, the reduced vestiture of the costal vein and the legs, and the bifid tips of the cerci.

LIMONIA (LIBNOTES) GRISEOLA sp. nov. Plate 1, fig. 13.

General coloration dark brownish gray; antennæ black throughout; mesonotal præscutum with indications of three brown stripes; knobs of halteres weakly darkened; femora yellow, the tips narrowly blackened; wings tinged with yellow, sparsely patterned with brown along cord and outer end of cell 1st M_2; wing tip narrowly darkened; basal section of R_{4+5} long, fully one-half Rs; free tip of Sc_2 and R_2 in transverse alignment; m-cu at midlength of cell 1st M_2; abdomen brownish black; cerci with simple tips.

Female.—Length, about 8 millimeters; wing, 8.5.

Rostrum and palpi black. Antennæ black throughout; flagellar segments oval, with verticils that are subequal in length to the segments; terminal segment fully twice as long as the penultimate, strongly narrowed outwardly. Head dark gray, the linear anterior vertex more silvery gray.

Mesonotal præscutum dark brownish gray, with three very indistinct dark brown stripes that are sparsely dusted with pollen; posterior sclerites of notum gray, the scutal lobes darker in centers. Pleura dark brown, dusted with gray. Halteres pale yellow, the knobs weakly infuscated. Legs with the coxæ darkened, their apices paler; trochanters yellow; femora yellow, the tips rather narrowly but conspicuously blackened; tibiæ brownish yellow, the tips narrowly blackened; basitarsi obscure yellow; remainder of legs broken. Wings (Plate 1, fig. 13) tinged with yellow, the prearcular and costal regions clearer yellow; wing tip in outer radial field weakly darkened; stigma narrow, appearing as a dark seam on R_2; narrow and very ill-defined dark clouds at origin of Rs, along cord, and on outer end of cell 1st M_2, chiefly indicated by a darkening of the veins at these points. Macrotrichia on longitudinal veins beyond cord and on distal half of M, Rs except base, and tips of both anal veins. Venation: Sc_1 ending about opposite midlength of the basal section of R_{4+5}, Sc_2 at its tip; Rs relatively long, about twice the long basal section of R_{4+5}; free tip of Sc_2 and R_2 in transverse alignment; cell 1st M_2 with outer elements subequal and transverse; veins beyond the cell elongate; m-cu at near midlength of cell 1st M_2; anal veins generally parallel at bases.

Abdomen brownish black throughout. Cerci relatively small, simple, blackened at bases.

Habitat.—Formosa.

Holotype, female, Hassensan, Taichu-shû, Reimei-Piawaikei-Baibarasan, July 13, 1932 (*Esaki*).

Limonia (*Libnotes*) *griseola* is somewhat similar to *L.* (*L.*) *hassensana* Alexander, likewise from Hassensan, but is really a very different fly. The unusually long basal section of R_{4+5} and very gently concave or sinuous vein 2d A furnish important characters, additional to those of coloration of the body, legs, and wings.

LIMONIA (DICRANOMYIA) KONGOSANA sp. nov. Plate 1, fig. 14; Plate 3, fig. 35.

Belongs to the *morio* group; size unusually large (wing, 9 millimeters or over); mesonotal præscutum polished black, the surface very sparsely pruinose; knobs of halteres brownish black; wings with the stigma dark brown, conspicuous, preceded and followed by cream-colored areas; Sc_1 longer than Rs; abdominal tergites black; male hypopygium with the caudal margin of tergite broadly emarginate, the lateral lobes obtuse; dorsal dististyle terminating in an acute spine; rostral spine of ventral dististyle fasciculate, from an enlarged base.

Male.—Length, about 8.5 millimeters; wing, 9.5.

Female.—Length, about 8.5 to 9 millimeters; wing, 9 to 9.5.

Rostrum black, sparsely pruinose; palpi black. Antennæ black throughout; flagellar segments oval. Head light gray; anterior vertex relatively wide.

Mesonotum black, the surface of præscutum very sparsely pruinose so as to dim the polished sclerites that are usual in the group; median region of scutum, base of scutellum, and mediotergite more heavily pruinose. Pleura black, heavily gray pruinose. Halteres elongate, yellow, the knobs brownish black. Legs with the fore coxæ black, their apices yellow; remaining coxæ light yellow; trochanters yellow; femora obscure yellow, the tips rather narrowly brownish black; tibiæ and tarsi brownish black. Wings (Plate 1, fig. 14) with a rather strong brown tinge, the oval stigma dark brown; prearcular region and costal border, including areas before and beyond stigma, more cream-colored; veins brown. Venation: Sc_1 ending opposite origin of Rs, Sc_2 far from its tip, Sc_1 alone about one-third longer than Rs; free tip of Sc_2 more than its own length basad of R_2, the section of R_1 between with abundant macrotrichia; m-cu at or close to fork of M; vein 2d A long, gently sinuous.

Abdominal tergites black; sternites obscure brownish yellow. Male hypopygium (Plate 3, fig. 35) with the caudal margin of

the ninth tergite, *9t*, broadly emarginate, the lateral lobes obtuse, with numerous long setæ. Basistyle, *b*, relatively large, its ventromesal lobe conspicuous. Dorsal dististyle, *dd*, strongly bent at near midlength, the apex an acute spine. Ventral dististyle, *vd*, relatively large and fleshy, the rostral prolongation stout, bearing a single powerful fasciculate spine from an enlarged base. Gonapophyses, *g*, with the mesal-apical lobe short. Ædeagus very large, at base with very abundant and dense erect setæ, on the dilated outer portions these much shorter and more scattered.

Habitat.—Korea.

Holotype, male, Kongo San, October 17, 1933 (*Machida*). Allotopotype, female, October 16, 1933. Paratopotypes, 3 females, October 8 to 17, 1933 (*Machida*).

The only near ally of the present fly in the Asiatic fauna is *Limonia* (*Dicranomyia*) *paramorio* (Alexander), which is much smaller, with the stigma pale and inconspicuous, and with a very different structure of the male hypopygium, notably of the dististyles and ædeagus. By Lackschewitz's key to the western Palæarctic species of the *morio* group[8] the present fly runs to couplet 4, including *L.* (*D.*) *caledonica* (Edwards) and *L.* (*D.*) *stylifera* (Lackschewitz), small species with very distinct male hypopygia. The present fly is by far the largest member of the group so far discovered.

ELLIPTERA ZIPANGUENSIS TAIWANICOLA subsp. nov.

Male.—Length, about 5 millimeters; wing, 7.3.

Characters as in typical *zipanguensis* Alexander, of Hokkaido, differing as follows: Mesonotum and pleura black, the surface sparsely pruinose. Legs black. Wings more strongly tinged with blackish. Venation: R_{2+3} short, poorly indicated, shorter than r-m. Abdomen, including sternites and hypopygium, black.

Habitat.—Southern Formosa.

Holotype, male, Keinensan, altitude 5,400 feet, August 17, 1933 (*Issiki*).

The discovery of the occurrence of a true *Elliptera* south of the Tropic of Cancer is of great interest, all other known species being recorded only from north of 30° north latitude. I am

[8] Ann. Naturhist. Mus. Wien 42 (1928) 218–219.

indebted to Mr. K. Takeuchi for a translation of the paper by S. Iwata,[10] written entirely in Japanese, where the following record is given:

7. *Elliptera*, sp. Distributed throughout the river but more especially in the lower portion. I found larvae, pupae and cast pupal skins.

The species in question, if a true *Elliptera*, may be *Elliptera jacoti* Alexander (Shantung, China; Korea) or *E. zipanguensis* Alexander (Hokkaido) or an undescribed species.

DICRANOPTYCHA NIGROTIBIALIS sp. nov. Plate 1, fig. 15.

General coloration of body dark brown or brownish black, the thorax dusted with yellow pollen; legs with the femora black, the bases obscure yellow, before the tips with indications of a more reddish brown ring; tibiæ and tarsi black; wing strongly tinged with brown, the prearcular and costal regions light yellow; veins dark brown; cell 1st M_2 unusually small, about two-thirds as long as Rs; R_{1+2} about twice R_2; abdomen dark brown.

Female.—Length, about 9.5 millimeters; wing, 10.5.

Rostrum and palpi dark brown. Antennæ light brown; scape yellow pollinose; outer six or seven flagellar segments passing into black; flagellar segments subcylindrical, the longest verticils fully twice the segments. Head yellowish gray; anterior vertex broad, nearly three times the diameter of scape.

Mesonotum dark brown or brownish black, dusted with yellow pollen; præscutum with indications of two narrow intermediate brown stripes; pseudosutural foveæ black, conspicuous. Pleura dark, heavily dusted with pollen, the dorsal pleurites considerably darker than the sternopleurite. Halteres pale, the knobs vaguely darkened. Legs with the coxæ brown, sparsely pollinose; trochanters obscure yellow; femora black, the bases obscure yellow, including about the basal fourth of the segment; indications of a vague, more reddish brown ring before tips of femora; tibiæ and tarsi black; legs with a long erect pubescence. Wings (Plate 1, fig. 15) strongly tinged with brown, the prearcular region and cells C and Sc light yellow; veins dark brown, luteous in the yellow areas. Venation: Cell 1st M_2 unusually small, only about two-thirds the length of Rs; R_{1+2} about twice R_2; m-cu shortly before midlength of cell 1st M_2.

[10] Aquatic insects of the Kamogawa River, Kyoto. V. Diptera, Trans. Kansai Ent. Soc. 1 (1930) 54.

Abdomen dark brown, including the dorsal shield of ovipositor; cerci horn-colored, relatively short; basal abdominal sternites obscure brownish yellow, the subterminal segments brownish black.

Habitat.—Southern Formosa.

Holotype, female, Fudieda, altitude 4,700 feet, August 13, 1933 (*Issiki*).

Dicranoptycha nigrotibialis is readily told from all other species in eastern Asia by the coloration of the legs. It is not closely allied to any of the three other species in Formosa.

PEDICIINI

DICRANOTA (RHAPHIDOLABIS) PLANA sp. nov. Plate 1, fig. 16; Plate 3, fig. 36.

General coloration light gray, the præscutum with three grayish brown stripes; antennæ black throughout; legs chiefly brownish black, the tarsi somewhat paler; wings with a pale grayish suffusion, the stigma scarcely indicated; R_{2+3+4} longer than r-m; abdomen dark brown; male hypopygium with the median area of tergite nearly transverse; setæ on mesal face of basistyle unusually strong and powerful, especially toward the proximal end; interbase a large, broadly flattened plate.

Male.—Length, about 4.5 millimeters; wing, 5.3.

Rostrum and palpi black, the former pruinose. Antennæ black throughout, short; flagellar segments oval, the outer segments broken. Head light gray.

Pronotum gray. Mesonotal præscutum clear blue-gray, with three grayish brown stripes, the median stripe not quite reaching the suture; posterior sclerites of notum dark plumbeous gray. Pleura gray, the dorsopleural membrane brown. Halteres pale, the knobs dusky. Legs with the coxæ gray; trochanters testaceous; femora dark brown, the tips narrowly blackened; tibiæ brown; tarsi elongate, rather pale brown, the outer segments blackened; posterior basitarsi subequal in length to tibiæ. Wings (Plate 1, fig. 16) with a pale grayish suffusion, the prearcular region pale yellow; stigma scarcely indicated, a trifle paler than the ground color, very diffuse; veins brown, more yellowish in the prearcular field. Venation: Sc_1 ending some distance beyond fork of R_{2+3+4}; Sc_2 far before origin of Rs; Rs rather strongly arcuated; R_2 erect, longer than R_{1+2}; cell R_3 petiolate, R_{2+3+4} being longer than r-m; m-cu more than one-half its length beyond the fork of M.

Abdomen dark brown. Male hypopygium (Plate 3, fig. 36) with the median region of the tergite, 9*t*, only slightly protuber-

ant, being virtually transverse, provided with numerous coarse setæ; lateral tergal spines, 9*t*, broad-based, twisted at midlength. Basistyle with setæ of mesal face very strong and powerful, becoming larger toward base of sclerite. Outer dististyle, *od*, with the usual spines; inner dististyle, *id*, with apex flattened into a spatula. Interbase, *i*, large, broadly flattened, shaped about as in the figure, the extreme margins of the two outer lobes very insensibly serrulate.

Habitat.—Southern Formosa.

Holotype, male, Keinensan, altitude 5,400 feet, August 14, 1933 (*Issiki*).

Dicranota (*Rhaphidolabis*) *plana* is conspicuously different from the only other described Formosan species of the subgenus, *D.* (*R.*) *atripes* Alexander, the hypopygium being very distinct in all details. The group of powerful setæ on mesal face of basistyle is suggestive of the condition in *D.* (*R.*) *consors* Alexander, of Honshiu and Kiushiu, but the other structures and body coloration are again very different. The degree of convexity of the median region of the tergite is the slightest known from any of the eastern Asiatic species of *Rhaphidolabis*, excluding the *flavibasis* group, where the caudal border of the tergite is deeply emarginate.

HEXATOMINI

LIMNOPHILA (PRIONOLABIS) HARUKONIS sp. nov. Plate 1, fig. 17; Plate 3, fig. 37.

Size small (wing, male, about 8 millimeters); general coloration polished coal-black; antennæ 13-segmented; knobs of halteres weakly darkened; femora blackened, the bases restrictedly yellow, more extensively so on the posterior legs where about the basal third is included; wings with a strong brown suffusion, only the prearcular region more yellowish; cord and outer end of cell 1st M_2 weakly seamed with dusky; R_2 and R_{1+2} subobsolete; male hypopygium with the caudal margin of tergite evenly emarginate between two blackened tubercles; outer dististyle with a single lateral denticle.

Male.—Length, about 6.5 millimeters; wing, 8.

Rostrum and palpi black. Antennæ black throughout, 13-segmented; basal flagellar segments short-oval, crowded, the outer segments more elongate; terminal segment about one-half longer than the penultimate. Head polished black, the front and anterior vertex little if any pruinose.

Prothorax and mesothorax entirely polished black, without pruinosity. Halteres obscure yellow, the knobs weakly dark-

ened. Legs with the coxæ and trochanters polished black; femora black, the bases narrowly pale, narrowest on forelegs, a little more extensive on the hind femora where about the basal third is brightened; tibiæ dark brown, the tips narrowly blackened; tarsi dark brown. Wings (Plate 1, fig. 17) with a strong brown suffusion, only the prearcular region yellower; stigma very poorly defined; origin of Rs, cord, and outer end of cell 1st M_2 very vaguely seamed with dusky; veins brownish black, more luteous in the prearcular field. Venation: R_2 and R_{1+2} both so faint as to be scarcely visible, apparently subequal, as figured; petiole of cell M_1 longer than the cell; m-cu at near midlength of cell 1st M_2.

Abdomen, including hypopygium, polished black. Male hypopygium (Plate 3, fig. 37) with the caudal margin of tergite, 9*t*, produced into a small blackened tubercle on either side of the median line, the space between gently and evenly emarginate. Outer dististyle, *od*, with a single lateral tooth, which is strongly developed into a curved black spine. Inner dististyle, *id*, before the obtuse blackened apical point bearing a slender tubercle that is tridentate at apex.

Habitat.—Formosa.

Holotype, male, Hassensan, Reimei, July 13, 1932 (*Esaki*).

This distinct species is named in honor of Miss Haruko Esaki, eldest daughter of Professor Teiso and Mrs. Lotte Esaki. It is very different from the other species having 13-segmented antennæ (*imanishii* Alexander, *lutcibasalis* Alexander) being more generally similar to *Limnophila* (*Prionolabis*) *oritropha* Alexander, a larger, yellow-winged species from the high mountains of Formosa. The diagnostic features listed above are sufficient to separate the fly from all allied forms. The males of *L.* (*P.*) *luteibasalis* and *L.* (*P.*) *odai* Alexander have the median region of the tergite narrowly and weakly trilobed, quite different from the condition found in other Japanese and Formosan species of *Prionolabis*.

HEXATOMA (ERIOCERA) MASAKII sp. nov. Plate 1, fig. 18.

Belongs to the *chirothecata* group; general coloration of mesonotal præscutum and scutum black, the pleura and posterior sclerites of mesonotum more brownish; head and abdominal tergites uniformly orange; antennæ (male) about twice as long as the wing, the basal four segments light yellow, the incisures of the basal two flagellar segments narrowly darkened; outer flagellar segments more uniformly darkened; flagellar segments

without spinous armature, only with conspicuous setæ that become longer on the outer segments; femora yellow, the tips narrowly but conspicuously blackened; wings tinged with brown, the costal border broadly darker brown, this color continued to the wing tip; abdominal tergites orange, the lateral borders and centers of the sternites variegated with black.

Male.—Length, about 11 millimeters; wing, 9.5; antenna, about 19.

Rostrum short, orange; palpi dark brown. Antennæ (male) elongate, approximately twice the length of the wing; scape, pedicel, and basal two flagellar segments yellow, the incisures narrowly but conspicuously dark brown; terminal segments more uniformly infuscated; flagellar segments with delicate scattered setæ only, without spines as is usual in the genus; setæ of outer segments much longer and more conspicuous than on the basal segments. Head orange; vertical tubercle very weakly notched at summit.

Pronotum and mesonotal præscutum and scutum blackened, the surface rather polished; scutellum and mediotergite more brownish. Pleura brown, the dorsal sclerites darker. Halteres black. Legs with the coxæ yellowish brown; trochanters obscure yellow; femora yellow, the tips narrowly but conspicuously blackened; tibiæ obscure yellow, the tips narrowly infuscated; basitarsi obscure yellow, the outer tarsal segments passing into black. Wings (Plate 1, fig. 18) with a brown tinge, the entire costal border to the wing tip conspicuously darker brown, this including cells C and Sc and the stigma; origin of Rs, cord and outer end of cell 1st M_2 more weakly suffused with brown; cell Cu paler than remainder of disk; veins brown. Macrotrichia of veins abundant, including complete series on all longitudinal radial veins beyond cord and more-scattered series on the outer sections of M_{1+2} and M_3. Venation: Rs elongate, considerably exceeding R; R_{2+3} longer than R_2; R_{1+2} longer than R_{2+3} but shorter than R_{2+3+4}; m-cu more than one-half its length beyond the fork of M.

Abdominal tergites orange, the lateral borders of segments narrowly blackened; sternites orange, the lateral borders darkened; segments two to seven each with a conspicuous median blotch; hypopygium more brownish orange.

Habitat.—Korea.

Holotype, male, Suigen, August 4, 1930 (*Tabashi*); No. 23.

The present fly is named in honor of Prof. Jujiro Masaki, who has added considerably to our knowledge of the Korean Tipulidæ. The species is very different from all other regional species with elongate antennæ in the male sex in the nonspinous flagellar segments, in conjunction with the rather striking coloration of the body and wings. I would believe it to be most nearly allied to *Hexatoma* (*Eriocera*) *kolthoffi* Alexander (eastern China: Kiangsu), of which only the female sex is known to this date. This latter fly differs in the yellow head, with entire vertical tubercle, the uniformly black legs, and the brownish black abdomen. It will be of interest to learn whether this species also has elongate antennæ, with reduced vestiture, as in the present fly.

ERIOPTERINI

CLADURA (CLADURA) MACHIDELLA sp. nov. Plate 1, fig. 19.

General coloration of entire body black, sparsely dusted with gray; fore femora black, only the extreme bases obscure yellow; posterior femora with outer third blackened; tarsi black; wings yellow, patterned with brown on the crossveins and distal two-thirds of Cu; supernumerary or adventitious crossveins in cells R_3 and R_4 in approximate alignment with R_2.

Female.—Length, about 9 millimeters; wing, 10.

Rostrum and palpi black. Antennæ black, only the extreme base of the first flagellar segment pale; flagellar segments cylindrical; terminal segment less than one-half as long as the penultimate. Head dark gray.

Mesonotum and pleura black, sparsely pruinose. Halteres pale yellow, the knobs very weakly darkened. Legs with the fore coxæ darkened, pale apically; remaining coxæ and all trochanters yellow; fore femora black, only the extreme bases obscure yellow; middle legs broken; posterior femora obscure yellow, the outer third blackened; tibiæ brown, the tips darker brown; basitarsi dark brown, the tips and all outer tarsal segments black. Wings (Plate 1, fig. 19) strongly tinged with yellow, the basal and costal portions brighter yellow; a conspicuous dark brown pattern, appearing as seams to the crossveins and certain of the longitudinal veins, as follows: Origin of Rs; cord; outer end of cell 1st M_2; Sc_2; fork of R_{2+3+4}; R_2; the supernumerary crossveins in cells R_3 and R_4; smaller dark spots at tips of veins R_{1+2}, R_3, and R_4; a broad, conspicuous, dark seam beginning at about one-third the length of vein Cu, extending uninterrupted to margin, slightly invading cell M and filling the

entire space between veins Cu_1 and Cu_2; veins yellow, dark in the clouded areas. Venation: Sc relatively long, Sc_1 ending about opposite m, Sc_2 opposite the fork of R_{2+3+4}; in the unique type, two supernumerary or adventitious crossveins, one each in cells R_3 and R_4, lying in almost perfect alignment with R_2 (in direct alignment in one wing; the element in cell R_3 just distad of the others, as figured, on the opposite side); r-m strongly arcuated and weakly spurred; petiole of cell M_1 slightly longer than m; m-cu shortly beyond the fork of M.

Abdomen black, the pleural membrane conspicuously more buffy yellow. Genital segment brownish yellow; valves of ovipositor reddish horn-color.

Habitat.—Japan (Honshiu).

Holotype, female, Mount Hiei, Kyoto, October 30, 1933 (*Machida*).

This strikingly distinct fly is named in honor of my friend Prof. Jiro Machida, to whom I am greatly indebted for kindly coöperation in studying the Tipulidæ of the Japanese Empire. It is the eighth Japanese and Formosan species of the genus to be described and is readily told from all other members of *Cladura* in the black coloration of the body and the chiefly black legs. It seems probable that the crossveins in the radial field of the wing may prove to be adventitious rather than supernumerary, a comparable condition being found in the genotype, *Cladura flavoferruginea* Osten Sacken, of eastern North America. This was studied by Alexander and Leonard [11] and the venation as regards crossveins was found to be remarkably plastic.

TRENTEPOHLIA (TRENTEPOHLIA) FUSCOBASALIS sp. nov. Plate 1, fig. 20.

Belongs to the *trentepohlii* group; characters as in *trentepohlii*, but basal segments of abdomen uniformly dark brown, almost as intense in color as the outer blackened segments.

Male.—Length, about 5.5 millimeters; wing, 5.4.

Female.—Length, about 7 millimeters; wing, 5.3.

Rostrum and labial palpi yellow; maxillary palpi darker. Antennæ black; flagellar segments long-oval to subcylindrical. Head dark gray; anterior vertex reduced to a linear strip or virtually lacking.

Mesonotal præscutum rather bright brown, more yellowish laterally; scutal lobes, scutellum, and mediotergite darker brown. Pleura brown, the posterior sclerites more yellowish. Halteres

[11] Journ. N. Y. Ent. Soc. 20 (1912) 36–39, pl. 4.

chiefly pale, the knobs slightly dusky. Legs with the fore coxæ pale brown, the remaining coxæ and all trochanters yellow; remainder of legs yellow, the terminal tarsal segments blackened. Wings (Plate 1, fig. 20) yellowish white, the costal region light yellow; wing tip, including radial and medial fields, more uniformly infuscated; narrow brown seams along cord and vein Cu; vein R_{4+5} + M_{1+2} narrowly seamed with dark brown, interrupting the otherwise pale band beyond cord; center of cell R_5 scarcely brightened; veins brown, luteous in the costal field. Venation: All veins in region of stigma so faint as to be virtually obliterated, the outer end of R, R_{1+2}, and R_2 being obsolete or nearly so; outer four-fifths of R_{2+3+4} very pale and semiatrophied but evident; cell 2d A relatively wide.

Basal abdominal segments dark brown, the outer segments a little more blackened.

Habitat.—Formosa.

Holotype, male, Tansui, October 29, 1933 (*Issiki*).

Allotype, female, Jitsugetsutan (Lake Candidius or Dragon Lake), November 4, 1932 (*Machida*).

This species, or perhaps race, has undoubtedly been confused in Formosa with *Trentepohlia* (*Trentepohlia*) *trentepohlii* (Wiedemann), which has the basal segments of the abdomen yellow or reddish yellow. The dark color of the basal abdominal segments of the present fly is not quite as intense as in the otherwise distinct *T.* (*T.*) *pictipennis* Bezzi (Luzon to Papua). The insect fauna of Lake Candidius has been well considered by Takahashi.[12]

Genus GONOMYIA Meigen

Subgenus PROTOGONOMYIA subgen. nov.

Characters much as in *Progonomyia* Alexander, differing especially in the short fleshy valves of the ovipositor. In all other subgeneric groups of *Gonomyia*, the valves are elongate, with acutely pointed cerci. Wings with cell R_3 deep, almost as in the genus *Gnophomyia*, the branches inclosing the cell subparallel or but slightly divergent on basal half; cell 1st M_2 open by atrophy of basal section of M_3; m-cu close to fork of M.

Type of subgenus.—*Gonomyia confluenta* Alexander (Oriental Region: Formosa).

Other included species: *Gonomyia* (*Protogonomyia*) *clitellata* sp. nov.; *G.* (*P.*) *nigripes* Brunetti (includes *nigra* Brunetti,

[12] Trans. Nat. Hist. Soc. Formosa 20 No. 108 (1930) 145–156.

incompleta Brunetti, and probably *gracilis* Brunetti); *G.* (*P.*) *perturbata* Alexander; and *G.* (*P.*) *scutellum-album* Alexander.

Gonomyia tenebrosa Edwards has the valves of the ovipositor elongate and sclerotized and should be retained in *Progonomyia*. The subgeneric position of *G. brunnescens* Edwards is still uncertain as the female has not been described.

GONOMYIA (PROTOGONOMYIA) CLITELLATA sp. nov. Plate 1, fig. 21; Plate 3, fig. 38.

Size small (wing, male, 4.5 millimeters); præscutum, scutum, and mediotergite black, the scutellum, pleura, and pleurotergite abruptly yellow; head black, dusted with gray; knobs of halteres orange-yellow; wings with a faint brown tinge; Sc_1 extending to about opposite midlength of Rs; R_{2+3+4} about twice the basal section of R_5; abdominal tergites black, the hypopygium and sternites yellow; male hypopygium with the spine of the inner dististyle long and acute; ædeagus slender, terminating in a small, acute, recurved spine.

Male.—Length, about 4 millimeters; wing, 4.5.

Rostrum and palpi black. Antennæ of moderate length, black throughout; flagellar segments oval. Head black, dusted with gray, more heavily so on anterior portions.

Pronotum brownish yellow, a little darker in front; anterior lateral pretergites clear light yellow. Mesonotal præscutum and scutum intense black, the surface somewhat opaque by a sparse bloom; scutellum light yellow, the parascutella darkened; mediotergite black. Pleura and pleurotergite yellow, somewhat more reddish yellow on ventral anepisternum and ventral sternopleurite. Halteres pale, the knobs orange-yellow. Legs with the fore and middle coxæ reddish yellow, the posterior coxæ clearer yellow; trochanters obscure yellow; remainder of legs broken. Wings (Plate 1, fig. 21) with a faint brown tinge; veins pale brown. Macrotrichia on all veins beyond cord; on Rs except basal fifth, distal third of M, and about the outer half of 2d A; vein 1st A without trichia. Venation: Sc_1 extending to about opposite midlength of Rs, Sc_2 not clearly apparent and omitted from figure; Rs very long; R_{2+3+4} about twice the basal section of R_5; cell M_1 longer than its petiole; m-cu close to fork of M.

Abdominal tergites black, the eighth and ninth tergites, including hypopygium, more yellowish; sternites yellow. Male hypopygium (Plate 3, fig. 38) with the basistyle, *b*, produced beyond the level of the insertion of the dististyles as a scooplike expanded blade, the apex obtuse; ventromesal lobe with retrorse setæ. Outer dististyle, *od*, yellow, gradually narrowed to the

apical spinous point, the lower or concave edge at midlength with abundant delicate setulæ. Inner dististyle, *id*, bifid at midlength, the shorter arm conspicuously setiferous, the longer arm decussate, appearing as a slender straight spine. Æedeagus, *a*, apparently slender, not highly compressed as in *scutellum-album*, the apex terminating in an acute recurved spine.

Habitat.—Northern Formosa.

Holotype, male, Rimosan, May 2, 1933 (*Issiki*).

Gonomyia (*Protogonomyia*) *clitellata* is very different from all other described members of the group. The peculiar thoracic pattern, together with the structure of the hypopygium, will readily serve to distinguish the species from the allied regional forms.

GONOMYIA (GONOMYIA) SEKIANA sp. nov. Plate 1, fig. 22; Plate 3, fig. 39.

Belongs to the *cognatella* group; antennæ black, the basal segments brighter; pleura with a broad whitish longitudinal stripe; knobs of halteres light yellow; legs black; abdominal tergites bicolorous, dark brown, the caudal borders conspicuously pale yellow; male hypopygium with three dististyles, the outer terminating in a curved black spine and bearing a lateral tooth at near two-thirds the length; phallosome large and conspicuous, more or less hood-shaped.

Male.—Length, about 5 millimeters; wing, 5.

Rostrum and palpi black. Antennæ black, the basal segments more obscure orange; antenna relatively long and slender, if bent backward extending about to wing root; flagellar segments long-oval, with an abundant short dense pubescence and long, unilaterally arranged verticils, one to each segment. Head with center of vertex darkened, the remainder obscure orange.

Pronotum pale yellow above, darkened laterally and beneath. Anterior lateral pretergites pale yellow. Mesonotal præscutum and scutum black, dusted with gray, the humeral and narrow lateral regions obscure yellow; median region of scutum obscure yellow; scutellum darkened basally, the broad posterior border yellow; mediotergite dark, with a narrow pale V-shaped transverse area at near midlength. Pleura with a broad whitish longitudinal stripe extending from behind the fore coxæ, crossing the dorsal sternopleurite, ventral pteropleurite, onto the meral region; dorsal anepisternum and ventral sternopleurite dark brown; remaining posterior sclerites of pleura more reddish brown. Halteres dusky, the knobs light yellow. Legs with the coxæ testaceous yellow; trochanters brownish yellow; femora

brownish black; tibiæ and tarsi black. Wings (Plate 1, fig. 22) with a pale brown tinge; prearcular region and cells C, Sc, and Cu_1 light yellow; stigma and vague seams along cord very pale brown; veins brown, yellow in the luteous areas. Macrotrichia relatively abundant on R_4, R_5, all outer branches of M and Cu, outer ends of both anal veins, almost the whole length of R_{2+3+4} and Rs, and on outer ends of M and basal section of Cu_1. Venation: Sc_1 ending opposite origin of Rs, Sc_2 close to its tip; m-cu shortly before fork of M.

Abdominal tergites dark brown, the caudal borders of the segments conspicuously pale; hypopygium yellow; sternites more uniformly yellow. Male hypopygium (Plate 3, fig. 39) with the outer angle of basistyle, *b*, produced into a long pale rod that is provided along its margin near base with about eight long powerful spinous setæ. Three dististyles, the outer, *od*, long and slender, terminating in a curved blackened point, at near two-thirds the length bearing a small acute spinous point; intermediate style, *md*, even longer, twisted on its own axis at base and again at proximal end of the long terminal black spine; inner style, *id*, shortest, its lower margin fringed with strong setæ; at near four-fifths the length with a long powerful spinous seta, at apex with other shorter but still powerful setæ. Phallosome, *p*, a very large, pale, more or less hood-shaped structure, shaped about as in figure.

Habitat.—Southern Formosa.

Holotype, male, Sekisan, altitude 6,000 feet, August 15, 1933 (*Issiki*).

The present fly is the first member of the *cognatella* group to be discovered in the Japanese Empire. It differs from the other regional species in eastern Asia, with the exception of *aperta* Brunetti, by the conspicuous yellow knobs of the halteres. From the latter species, of which the male hypopygium has not been adequately described, the present fly differs in the details of coloration of the thorax, the black legs, and, if Bagchi's figure of the venation is correct, in the venation, as the less strongly arcuated Rs, very strongly arcuated R_{2+3+4}, and oblique R_3. The male hypopygium is much larger and more complex in structure than in *Gonomyia* (*Gonomyia*) *subcognatella* Alexander, of western China.

ERIOPTERA (ILISIA) LULIANA sp. nov. Plate 1, fig. 23; Plate 3, fig. 40.

Allied to *incongruens;* mesonotum and pleura light gray, with three velvety black longitudinal stripes, one on lateral borders

of præscutum and scutum, the other two more ventral, on pleura; femora yellow, the fore femora with two brown annuli, inclosing a narrow yellow subterminal ring; middle and posterior femora with a narrow brown subterminal ring; wings whitish subhyaline, with major ocelliform areas bordered by brown but without brown dots elsewhere in the cells; cell 1st M_2 small; male hypopygium with the tergite deeply split medially; gonapophyses slender, the margins smooth.

Male.—Length, about 5 millimeters; wing, 5.5.

Rostrum and palpi black. Antennæ with basal segment black, succeeding segments pale brown, the outer four or five segments again blackened. Head brownish gray.

Mesonotal præscutum light gray, with indications of two intermediate and two nearly lateral brown stripes that are present on posterior half of sclerite only; lateral borders of præscutum and scutum broadly and conspicuously intense velvety black; pseudosutural foveæ and tuberculate pits black; posterior sclerites of notum light gray, the central portions of scutal lobes and posterior border of scutellum more darkened. Pleura gray, traversed by two longitudinal velvety black stripes, the more dorsal extending from the fore coxæ across the ventral anepisternum and pteropleurite to pleurotergite; ventral stripe occupying the ventral sternopleurite and upper meral region; besides these two major stripes, the gray pruinosity is further lined with minor dark stripes on the more ventral gray vitta and on the ventral part of meron; dorsopleural membrane brown. Halteres yellow, the knobs very weakly darkened. Legs with the coxæ black, the posterior pair more pruinose; trochanters brownish black, more darkened beneath; fore femora yellow, with a broad dark brown ring at midlength, together with a paler brown ring at apex, its more basal portion darker, the two rings inclosing a narrow yellow subterminal annulus; middle and hind femora yellow, with a narrow brown subterminal ring; fore tibiæ yellow, a little infuscated near base; remainder of tibiæ and tarsi yellow, the outer tarsal segments black. Wings (Plate 1, fig. 23) whitish subhyaline; cells C and base of Sc uniformly infumed with pale brown; a conspicuous ocelliform pattern, beyond the cord with the central portions light brown, narrowly bordered by darker brown; basad of cord, the centers of the areas are of the ground color, their position and size indicated only by the dark borders; the largest of these areas lie at origin of Rs, anterior cord, and tip of Sc; stigmal area at end of

R_{1+2}; an oblique crossband before wing tip, extending from outer end of cell R_2 into extreme outer angle of cell M_4; wing margin in outer ends of cells R_5 to M_3 darkened; other pale circles at outer ends of cells M_4, Cu, and 2d A, and at tip of vein 1st A; no dark dots on wing excepting one or two along vein Cu; veins yellow, darker in the infuscated areas, as along the cord, outer end of cell 1st M_2 and outer end of vein 2d A. Venation: Cell 1st M_2 unusually small, the second section of vein M_{1+2} being less than two-fifths of the outer section; m-cu more than one-half its length before fork of M.

Abdomen chiefly dark brown, the lateral borders of tergites more reddish brown; hypopygium light yellow. Male hypopygium (Plate 3, fig. 40) with the ninth tergite, 9*t*, entirely pale, with a deep median split, the lateral lobes thus formed broadly truncate. Outer dististyle, *od*, relatively slender, gently arcuated. Inner dististyle, *id*, entirely pale, with a long retrorse seta at apex. Gonapophyses appearing as slender smooth black horns, *p*, their tips gently incurved, on mesal face near base produced into a weak denticle.

Habitat.—Central Formosa.

Holotype, male, Hassensan, Taichû-shû, Reimei, July 12, 1932 (*Esaki*).

This beautiful *Ilisia* is named in honor of Miss Luli Esaki, youngest daughter of Professor and Mrs. Teiso Esaki. The only near ally in eastern Asia is *Erioptera* (*Ilisia*) *incongruens* Alexander (Honshiu), which differs in the brown coloration of the mesothorax, the thickly dotted interspaces of the wings, the large cell 1st M_2, the differently patterned legs, and the structure of the male hypopygium, especially the stout, approximated apophyses with the surface microscopically roughened, and the group of about a dozen long slender spines grouped on either side of the median line at base of the phallosome.

MOLOPHILUS EPHIPPIGER sp. nov. Plate 1, fig. 34; Plate 3, fig. 41.

Belongs to the *gracilis* group and subgroup; mesonotum black, contrasting abruptly with the reddish yellow pleura and pleurotergite; male hypopygium with the dorsal lobe of basistyle low, nonspinous; outer dististyle a simple sinuous rod, with abundant serrulations on the distal two-thirds; inner dististyle black, the apex split into two slightly divergent black spines.

Male.—Length, about 3.5 millimeters; wing, 4.5.

Female.—Length, about 4 millimeters; wing, 4.5.

Rostrum pale brown; palpi black. Antennæ short; scape light yellow, pedicel light brown, flagellum dark brown; flagellar segments oval. Front and anterior part of vertex light yellow, the remainder of vertex and the occiput dark plumbeous gray.

Pronotum and anterior lateral pretergites yellow. Mesonotal præscutum and scutum entirely polished black, the remaining sclerites of notum black, but slightly more opaque by a sparse pruinosity; lateral portions of mediotergite brightened. Pleura, including the dorsopleural membrane and pleurotergite, pale reddish yellow, contrasting abruptly with the notum. Halteres yellow, the knobs and outer portions of stems a little darkened, with pale setæ. Legs with the coxæ and trochanters yellow, femora brown, paler basally, darkened toward tips, with dark setæ; tibiæ brown, darker toward tips; tarsi black. Wings (Plate 1, fig. 24) with a faint brown tinge, the prearcular and costal regions light yellow; veins pale brownish yellow, the macrotrichia darker brown. Venation: R_2 in transverse alignment with r-m; petiole of cell M_3 nearly three times m-cu; vein 2d A ending opposite posterior end of m-cu.

Abdominal tergites dark brown medially, the intermediate segments broadly yellow laterally; sternites yellow, somewhat darker in female; hypopygium brownish yellow. Male hypopygium (Plate 3, fig. 41) with the dorsal lobe, *db*, of basistyle low, nonspinous, its apex subacute but entirely pale and with setæ to apex; mesal lobe with dense setulæ; ventral lobe, *vb*, longest, at apex with conspicuous retrorse setæ and with a row of erect setæ along margin. Outer dististyle, *od*, a simple, sinuous, ribbonlike rod, yellow on basal third, the remainder blackened; outer margin and surface on blackened portions with microscopic serrulations, on inner edge more limited to distal third. Inner dististyle, *id*, a shorter blackened rod, the apex split into two slightly divergent, acute, black spines that are slightly unequal in length and diameter. Ædeagus long and slender.

Habitat.—Central Formosa.

Holotype, male, Rantaisan, altitude 7,000 feet, May 16, 1933 (*Issiki*). Allotopotype, female, in copula with male.

Molophilus ephippiger is very different from all other regional species in the black mesonotum, contrasting abruptly with the pale pleura, and in the structure of the male hypopygium, notably the bifid inner dististyle.

ILLUSTRATIONS

[*a*, aedeagus; *b*, basistyle; *d*, dististyle; *dd*, dorsal dististyle; *db*, dorsal lobe of basistyle; *g*, gonapophysis; *i*, interbase; *id*, inner dististyle; *md*, intermediate dististyle; *od*, outer dististyle; *p*, phallosome; *s*, sternites; *t*, terkites; *vb*, ventral lobe of basistyle.]

PLATE 1

FIG. 1. *Trichocera mirabilis* sp. nov., venation.
2. *Dictenidia inaequipectinata* sp. nov., venation.
3. *Dolichopeza* (*Dolichopeza*) *issikiella* sp. nov., venation.
4. *Dolichopeza* (*Mitopeza*) *taiwanicola* sp. nov., venation.
5. *Tipula* (*Trichotipula*) *haplotricha* sp. nov., venation.
6. *Tipula* (*Vestiplex*) *nestor* sp. nov., venation.
7. *Tipula* (*Vestiplex*) *parvapiculata* sp. nov., venation.
8. *Tipula* (*Oreomyza*) *koreana* sp. nov., venation.
9. *Tipula* (*Oreomyza*) *obnata* sp. nov., venation.
10. *Limonia* (*Limonia*) *melas* sp. nov., venation.
11. *Limonia* (*Limonia*) *tabashii* sp. nov., venation.
12. *Limonia* (*Libnotes*) *basistrigata* sp. nov., venation.
13. *Limonia* (*Libnotes*) *griseola* sp. nov., venation.
14. *Limonia* (*Dicranomyia*) *kongosana* sp. nov., venation.
15. *Dicranoptycha nigrotibialis* sp. nov., venation.
16. *Dicranota* (*Rhaphidolabis*) *plana* sp. nov., venation.
17. *Limnophila* (*Prionolabis*) *harukonis* sp. nov., venation.
18. *Hexatoma* (*Eriocera*) *masakii* sp. nov., venation.
19. *Cladura* (*Cladura*) *machidella* sp. nov., venation.
20. *Trentepohlia* (*Trentepohlia*) *fuscobasalis* sp. nov., venation.
21. *Gonomyia* (*Protogonomyia*) *clitellata* sp. nov., venation.
22. *Gonomyia* (*Gonomyia*) *sekiana* sp. nov., venation.
23. *Erioptera* (*Ilisia*) *luliana* sp. nov., venation.
24. *Molophilus ephippiger* sp. nov., venation.

PLATE 2

FIG. 25. *Trichocera mirabilis* sp. nov., male hypopygium.
26. *Tipula* (*Trichotipula*) *haplotricha* sp. nov., male hypopygium, details.
27. *Tipula* (*Vestiplex*) *nestor* sp. nov., male hypopygium, details.
28. *Tipula* (*Vestiplex*) *parvapiculata* sp. nov., male hypopygium, details.
29. *Tipula* (*Vestiplex*) *parvapiculata* sp. nov., male hypopygium, details.
30. *Tipula* (*Acutipula*) *obtusiloba* sp. nov., male hypopygium, details.
31. *Tipula* (*Oreomyza*) *koreana* sp. nov., male hypopygium, details.
32. *Tipula* (*Oreomyza*) *obnata* sp. nov., male hypopygium, details.

PLATE 3

FIG. 33. *Limonia* (*Limonia*) *melas* sp. nov., male hypopygium.
34. *Limonia* (*Limonia*) *tabashii* sp. nov., male hypopygium.
35. *Limonia* (*Dicranomyia*) *kongosana* sp. nov., male hypopygium.
36. *Dicranota* (*Rhaphidolabis*) *plana* sp. nov., male hypopygium.
37. *Limnophila* (*Prionolabis*) *harukonis* sp. nov., male hypopygium.
38. *Gonomyia* (*Protogonomyia*) *clitellata* sp. nov., male hypopygium.
39. *Gonomyia* (*Gonomyia*) *sekiana* sp. nov., male hypopygium.
40. *Erioptera* (*Ilisia*) *luliana* sp. nov., male hypopygium.
41. *Molophilus ephippiger* sp. nov., male hypopygium.

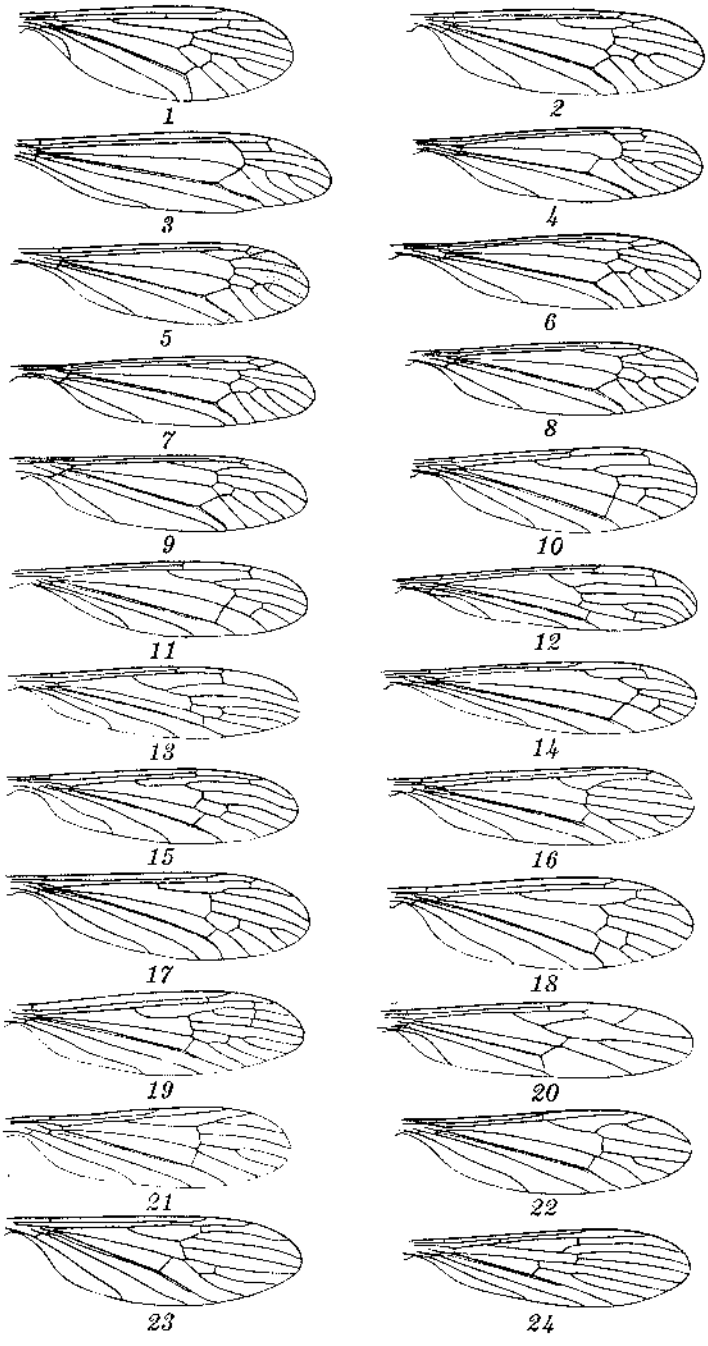

PLATE 1.

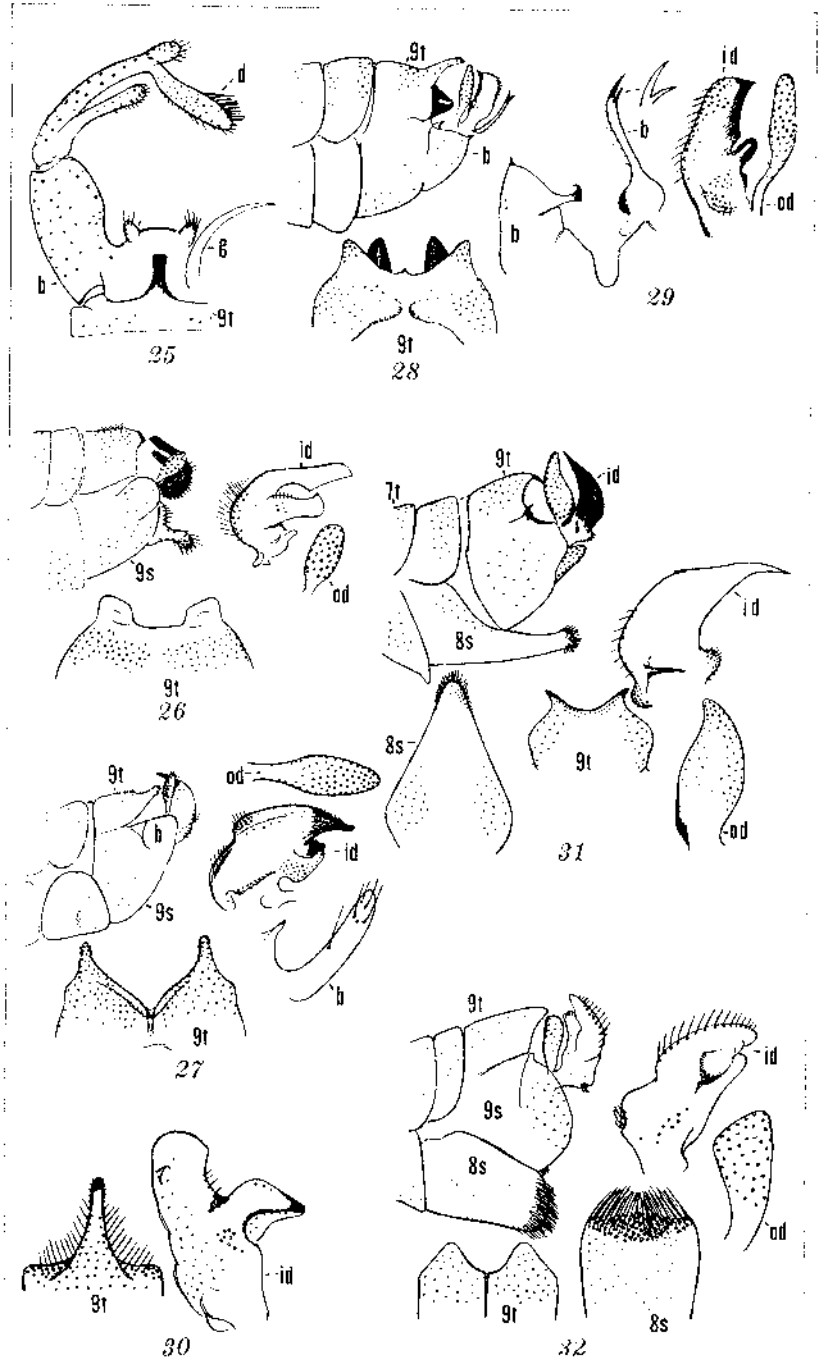
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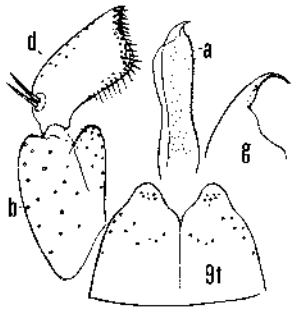
PLATE 2.



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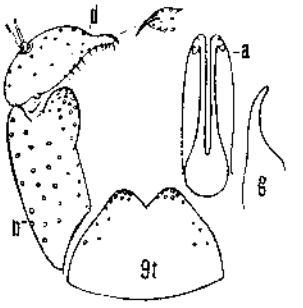

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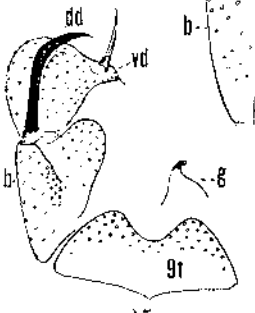

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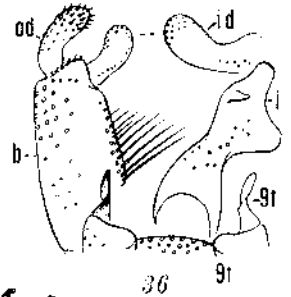

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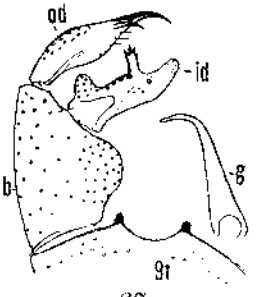

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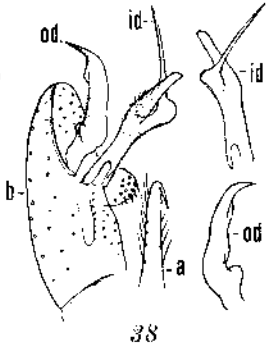

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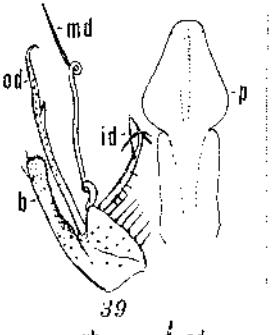

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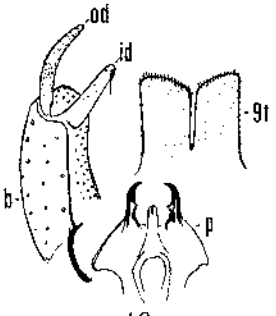

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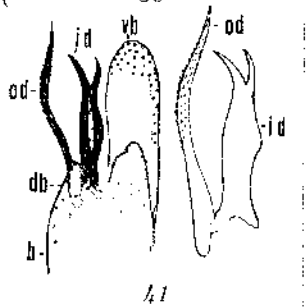

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PLATE 3.

FOOD HABITS OF SIX COMMON LIZARDS FOUND IN LOS BAÑOS, LAGUNA, PHILIPPINE ISLANDS [1]

By DEOGRACIAS V. VILLADOLID

Of the Fish and Game Administration, Bureau of Science, Manila

This report is based upon the examination of the contents of one hundred twenty-six well-filled stomachs of six species of lizards. These lizards were collected by students enrolled in zoölogy during the school year 1927–1928. The relative abundance of the food constituents was ascertained by the frequency of their occurrence in each of the stomachs examined.

The results of this study are embodied in two tables. Table 1 gives the actual composition of the stomach contents examined. Table 2 gives the relative abundance of the food constituents found.

FOOD OF HEMIDACTYLUS FRENATUS DUMÉRIL AND BIBRON

The contents of forty-five stomachs consisted mostly of insect material; five stomachs contained spiders (arachnids) in addition to insects, while one lizard apparently swallowed also crustacean food and a bean besides insects.

Insect food.—The bulk of the stomach contents of twenty-two of the forty-five lizards examined consisted of Orthoptera, mostly roaches (Blattidæ), green crickets (Oecanthidæ), and tree crickets (Gryllacridæ). Small beetles (Coleoptera), the second most important food item of this lizard, were found in thirteen stomachs. Other orders of insects represented in the food of *H. frenatus,* in the order of their frequency, are Diptera (mostly flies), Homoptera (mostly leaf hoppers), Isoptera (mostly winged termites), Hymenoptera (mostly ants), and Odonata (dragon flies).

Animal food other than insects.—Arachnids (spiders) were found in six stomachs only. The order Crustacea was repre-

[1] The data were secured by the writer during his incumbency as assistant professor of zoölogy, College of Agriculture, University of the Philippines.

sented by a species of fresh-water prawn (*Palæmon lanceifrons* Dana) found in a single stomach. It is most likely that the prawn, as well as a bean in the stomach of the same lizard, was picked up from a food cabinet, as this lizard is a frequent visitor to human habitations.

FOOD OF GEKKO GECKO (LINNÆUS)

Seventeen stomachs of this lizard contained insects. One also contained a scorpion (Arachnida) besides insects, and another contained a centipede (Chilopoda) in addition to insects.

Insect food.—Orthoptera (mostly Locustidæ, Blattidæ) and Coleoptera (mostly Curculionidæ and Cerambycidæ) formed the bulk of the food of the geckos.

Animal food other than insects.—Very little noninsect food was found in the stomachs of the geckos. One scorpion (Arachnida) was found in a single stomach, while another stomach yielded three centipedes (Chilopoda).

FOOD OF DRACO SPILOPTERUS (WIEGMANN)

Twenty stomachs of this lizard contained insects. These belonged to only two orders; namely, Hymenoptera and Coleoptera; ants form the bulk of the food. It seems then that this flying lizard has a marked preference for ants. Fire ants of the genus *Odontomachus* (Formicidæ), called "hantic" locally, were common in the stomachs of the flying lizards. Beetles of the family Curculionidæ were found in three stomachs.

FOOD OF MABUYA MULTIFASCIATA KUHL

Insect food.—Fifteen stomachs examined contained insects. This lizard showed a marked preference for Orthoptera, mostly grasshoppers (Locustidæ) and crickets (Gryllidæ). Ten of the fifteen stomachs contained nothing but grasshoppers and crickets. Other insects found were beetles (Coleoptera), moths (Lepidoptera), and ants, bees, and other Hymenoptera.

Animal food other than insects.—Spiders were found in three stomachs examined. A fresh-water snail (*Melania* sp.) was found in a single stomach.

Vegetable constituent.—A piece of leaf was found in a single stomach. This was possibly taken accidentally.

FOOD OF CALOTES MARMORATUS (GRAY)

The bulk of the food of this lizard consisted of beetles of the families Cicindelidæ and Passalidæ, and Orthoptera, mostly

grasshoppers and crickets. Other insect foods in the order of their frequency were Hymenoptera (ants and bees), Homoptera (mostly leaf-hoppers), and Diptera (flies and mosquitoes).

Millipedes (Diplopoda) were found in only two stomachs. Vegetable material in the form of leaves and leaf sheaths were found in four stomachs. A tiny bit of decaying twig was found in one stomach.

FOOD OF TROPIDOPHORUS GRAYI GÜNTHER

Ten stomachs of this lizard contained nothing but insects belonging to the following orders, enumerated in the order of their importance: Orthoptera (mostly roaches, Blattidæ), Coleoptera (beetles), and Odonata (dragon flies).

SUMMARY AND REMARKS

1. Although the species of lizards examined are rather common in Los Baños and vicinity, the number of stomachs dissected for each kind is not sufficiently large to enable us to draw definite conclusions. Although a large number of species were present in the collection, only those which had well-filled stomachs were used. Also specimens in excellent condition for museum purposes were not sacrificed for dissection.

2. It is apparent that the six species of lizards examined are all insectivorous. In the 126 stomachs dissected, the bulk of the food consisted of insects. Very few contained food other than insects, the noninsect food constituting only a very minor portion of the stomach contents.

3. It is likewise apparent that these lizards feed more on noxious insects than on beneficial ones.

4. Orthoptera, Coleoptera, Diptera, Lepidoptera, and Homoptera formed the bulk of the insect food of the house lizard. This is to be expected in view of the fact that these insects are the ones usually found attracted by the light during which time this lizard is feeding actively. Diptera that are not attracted by light must have been taken during daytime. At any rate flies are usually found in houses during daytime. The probable reason why winged termites were not represented in a larger percentage in the stomachs of the lizards, although this insect is easily attracted to the light, is its periodic occurrence.

5. Beetles of the families Curculionidæ and Cerambycidæ, and orthopterous insects of the family Blattidæ, formed the bulk of the food of the geckos. This was to be expected in view of

the habit of the geckos of frequenting holes in trees and the underside of bark, which are also the favorite haunts of beetles and roaches. It is because of this habit also that the geckos pick up centipedes and scorpions.

6. The flying lizards, *Draco spilopterus*, showed a marked food preference for ants. Even the fierce, biting fire ants were found in a relatively large proportion in the stomachs of this lizard. Each of the twenty stomachs dissected contained a few beetles.

7. The "chameleon," *Calotes marmoratus*, showed a rather marked preference for Coleoptera and Orthoptera.

8. The shrub lizard, *Mabuya multifasciata*, showed preference for Orthoptera, notably grasshoppers and crickets. This is probably due to the fact that these insects are generally found among grasses and shrubbery, which are the favorite feeding grounds of this lizard. The presence of a fresh-water snail in one of the stomachs of this lizard might be taken as an indication that it visits water once in a while. This gives also a possible explanation to a superstition among the Filipinos that this lizard, locally known as "bankalang," goes to the water to drink after biting, and if it reaches the water ahead of the victim, its bite becomes poisonous and fatal.

9. The food of the spiny lizard, *Tropidophorus grayi*, consisted of insects such as locusts, grasshoppers, leaf hoppers, and dragon flies, which frequent shrubbery and small trees along the creek. This lizard is generally confined to this type of habitat.

TABLE 1.—*Showing the actual composition of the stomach contents of six species of lizards.*

House lizard, *Hemidactylus frenatus* Duméril and Bibron:
- Insecta—
  - Orthoptera; 39 grasshoppers and locusts; 3 cockroaches.
  - Coleoptera; 25 beetles.
  - Diptera; 10 flies; 7 mosquitoes.
  - Lepidoptera; 13 moths.
  - Homoptera; 17 leafhoppers.
  - Isoptera; 8 winged termites.
  - Hymenoptera; 18 ants.
  - Odonata; 1 dragon fly.
  - Insect remains; significant amount.
- Arachnida; 7 spiders.
- Crustacea; 5 small fresh-water prawns.
- Vegetable material; 1 bean seed.
- Inorganic material; a few minute pieces of sand.

TABLE 1.—*Showing the actual composition of the stomach contents of six species of lizards*—Continued.

Flying lizard, *Draco spilopterus* Wiegmann:
Insecta—
Hymenoptera; 400 ants (Formicidæ); 100 "hantic" fire ants; genus *Odontomachus*.
Coleoptera; 6 beetles (Curculionidæ).
Gecko, *Gekko gecko* Linnæus:
Insecta—
Coleoptera; 30 beetles (Curculionidæ); 5 beetles (Cerambycidæ).
Orthoptera; 9 roaches (Blattidæ); 7 locusts and grasshoppers.
Unidentified insect remains; significant.
Arachnida; 1 scorpion.
Chilopoda; 1 centipede.
Vegetable material; 2 small grass leaves and 1 rice hull.
Shrub lizard, *Mabuya multifasciata* Kuhl:
Insecta—
Orthoptera; 13 locusts; 8 crickets.
Coleoptera; 2 beetles.
Lepidoptera; 4 pupæ of moths or butterflies.
Isoptera; 10 winged termites.
Hymenoptera; 1 ant.
Insect remains; significant quantity.
Arachnida; 3 spiders.
Mollusca; 1 fresh-water snail.
Vegetable matter; 3 minute pieces of straw.
Chameleon, *Calotes marmoratus* Gray:
Insecta—
Coleoptera; 30 beetles (Curculionidæ); 1 beetle (Cicindelidæ); 2 beetles (Passalidæ).
Orthoptera; 21 locusts and grasshoppers.
Hymenoptera; 50 ants (Formicidæ); 1 bee.
Diptera; 1 fly; 2 mosquitoes.
Insect remains; significant quantity.
Diplopoda; 2 millipedes.
Vegetable material; 3 small leaves and 2 leaf sheaths.
Spiny lizard, *Tropidophorus grayi* Günther:
Insecta—
Orthoptera; 10 locusts and grasshoppers; 2 cockroaches.
Hymenoptera; 18 ants.
Coleoptera; 4 beetles.
Odonata; 3 dragon flies.
Insect remains; significant quantity.

TABLE 2.—*Showing the relative abundance of the food constituents.*

HEMIDACTYLUS FRENATUS; 45 STOMACHS.

Food item.	Stomachs in which found.	Percentage of occurrence
Insecta (insects)	45	100.00
Orthoptera	22	48.88
Coleoptera	13	28.88
Diptera	9	20.00
Lepidoptera	7	15.55
Homoptera	6	13.33
Isoptera	3	6.66
Hymenoptera	3	6.66
Odonata	1	2.22
Arachnida (spiders)	6	13.33
Crustacea (prawn)	1	2.22
Vegetable matter	1	2.22
GEKKO GECKO; 17 STOMACHS.		
Insecta (insects)	17	100.00
Coleoptera	9	52.94
Orthoptera	7	41.20
Arachnida (scorpion)	1	5.89
Chilopoda (centipede)	1	5.89
Vegetable matter	2	11.78
DRACO SPILOPTERUS; 20 STOMACHS.		
Insecta (insects)	20	100.00
Hymenoptera (ants)	20	100.00
Coleoptera (beetles)	3	15.00
CALOTES MARMORATUS; 19 STOMACHS.		
Insecta (insects)	19	100.00
Coleoptera	12	63.16
Orthoptera	10	52.63
Hymenoptera	4	21.05
Homoptera	1	5.03
Diptera	1	5.03
Diplopoda (millipede)	2	10.50
Vegetable matter	6	31.57

TABLE 2.—*Showing the relative abundance of the food constituents*—Ctd.

MABUYA MULTIFASCIATA; 15 STOMACHS.

Food item.	Stomachs in which found.	Percentage of occurrence.
Insecta (insects)	15	100.00
Orthoptera	10	66.66
Coleoptera	1	6.66
Lepidoptera	1	6.66
Isoptera	1	6.66
Hymenoptera	1	6.66
Arachnida (spiders)	3	20.00
Mollusca (fresh-water snail)	1	6.66
Vegetable matter	2	12.32
TROPIDOPHORUS GRAYI; 10 STOMACHS.		
Insecta (insects)	10	100.00
Orthoptera	4	40.00
Hymenoptera	3	30.00
Coleoptera	2	20.00
Odonata	1	10.00

FOOD AND FEEDING HABITS OF THE BARRED GROUND DOVE

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ONE PLATE

INTRODUCTION

The abundance of the barred ground dove, *Geopelia striata* (Linnæus) (Plate 1), in and near rice paddies makes the study of its economic importance significant in a country like the Philippines.

The bird has several vernacular names descriptive of either its appearance or its habits. Around Manila it is known as *bato batong katigbi, bato batong lupa,* and *bato batong kurokotok.* These are all Tagalog names. The first refers to its color pattern which resembles the various shades of the seeds of a certain graminaceous plant called katigbi, *Coix lachrymajobi* Linn. The second denotes its ground habit, while the third is based on its cooing note. Wherever the barred ground dove occurs, its presence is known through the description that its name presents and its cooing note which sounds like "Kurr-rok kotók kok kok," soft and repeatedly uttered. Baker,(1) citing Davison, states that the note "sounds like 'kok-akurr-kurr' soft, but repeated several times."

Detailed systematic descriptions are given, among others, by Salvadori,(9) McGregor,(8) Baker,(1) and Hachisuka.(5)

DISTRIBUTION

The species has a wide distribution. According to Baker,(1) it "is found in the extreme south of Tenasserim, whence it ranges south throughout the Malay Peninsula and Archipelago, as far east as the Philippines and in Siam, but is apparently rare in the latter place and was never met with by Count Guildenstolpe in 1911–12." Hachisuka(5) states that *G. striata*

"was introduced into Seychelles, Madagascar, Mauritius, Réunion, St. Helena, Hawaii and Round Island in West Australia."

In the Philippines McGregor(8) says: "while one of the commonest species in Luzon, occurs but rarely in other islands of the Archipelago."

OBJECT OF THE STUDY

The object of this study was to determine the food, the amount taken, and the feeding habits of this species in the regions where collecting was done.

TIME AND PLACE OF THE WORK

Collecting of specimens covers a period of over a year, from July, 1932, to July, 1933. The difficulties encountered in hunting materials cause the divergence in the number of stomachs obtained monthly for examination.

Collecting was done in fifty-six places in ten provinces, all in Luzon.[2] Observations were made in more places and through a longer period of time than actual collecting.

RESULTS AND DISCUSSION

Three hundred five stomachs of the barred ground dove were examined. At an early stage of the investigation it became evident that field observations afforded a very useful source of information, this being confirmed by the results of the stomach examination, analyzed volumetrically.(3, 7) Since further observations verified those made previously, it was thought best to suspend the destruction of more birds and to draw conclusions from the materials already on hand.

Materials have been examined in all the months of the year except September and January. The birds were obtained either in open fields or in nearby brushlands.

FIELD OBSERVATIONS

The birds were noted to alight in the open fields, walking, hunting, and picking food. In all observations made, they were not seen to stretch their heads to reach a seed on the stalk. Either seeds on the ground or those close to the ground, which they encounter in their search, comprised their food. During feeding time they rarely go singly, and seldom in a flock of four or six individuals. They are usually in pairs. About harvest time they frequent the rice fields where they feed on rice grains

[2] No specimen of this species was seen about Hinigaran, Occidental Negros, in October, 1933.

on the ground. These seeds are abundant after the harvest, consequently the barred ground doves are seen in these places oftener. Due probably to the very soft mud, the barred ground doves do not molest rice seeds in the seed bed. At other times they were noted to feed on the seeds of various species of weeds. While feeding they are cautious, and the approach of a man will cause their sudden flight to the neighboring brush. They were heard cooing in coco groves, but always seen feeding on the ground. These observations confirm those of other workers. McGregor(8) mentions the bird as often feeding in rice fields after harvest. Robinson, who states that in Malay Peninsula it is found searching the ground for seeds, etc., has been cited by Baker.(1) In India, Mason(6) reported that this species feeds "chiefly on seeds on ground." Dammerman,(4) describing the habits of this species in the Malay Archipelago as a whole, states that these birds visit the rice fields only after the harvest to search for the grain left behind.

EXAMINATION OF STOMACH CONTENTS

The results of the examination of stomach contents indicate that except in one instance when a bird collected in Pililla, Rizal Province, had fed on 170 dipterous pupæ, the food of the species consists of seeds of grain and weeds. The bird's feeding on the insects is considered accidental, although it does not exclude the species from the possibility of being an insectivore.

Table 1 shows that the largest number of collecting grounds[3] from which the greatest number of birds were obtained from a single province is in Rizal. It should also be noted that almost continuous collecting of materials for study was made in this province throughout the year. The reason for this is the accessibility of this province to Manila from where collecting parties were sent out for short periods at occasional intervals. It may be seen that, except in Bulacan Province where 51 per cent of the food of seven birds studied was rice, the bulk of the food of the barred ground dove, by province, consists of weed seeds. In Nueva Ecija, however, the presence of 100 per cent weed seeds in the stomachs of eleven birds may not represent

[3] For convenience, a collecting ground referred to in this paper is a place where specimens have been obtained each time, thus a particular place may appear 2 in the table if specimens were obtained there at two different periods. Generally, however, collecting was not made at exactly the same spot although within the municipality where ecological conditions are usually uniform.

TABLE 1.—*Food of the barred ground dove in different provinces.*

Province.	Collecting grounds.	Stomachs examined.	Weed seeds in total food.	Rice seeds in total food.
			P. ct.	*P. ct.*
Pangasinan	7	63	77	23
Zambales	6	23	74	26
Bataan	3	8	64	36
Tarlac	2	4	92	8
Nueva Ecija	3	11	100	
Pampanga	6	36	56.8	43.2
Bulacan	7	53	48.7	51.3
Rizal	16	87	69.6	30.4
Laguna	4	11	87.5	12.5
Batangas	3	9	95	5

TABLE 2.—*Food of the barred ground dove in different months.*

Month.	Stomachs examined.	Weed seeds in total food.	Rice seeds in total food.
		P. ct.	*P. ct.*
February	71	56	44
March	10	39.3	60.7
April	4	89	11
May	6	42	58
June	40	90	10
July	30	91.5	8.5
August	13	93.5	6.5
October	15	100	
November	3	7	93
December	113	68.2	31.8

the situation per se as collecting in that province was done only at one time in three places close to each other. The same is true of the materials from Tarlac.

Collecting in Pangasinan, Zambales, and Bataan Provinces was made within one month. Many places distant from each other were, however, involved. In Batangas, collections from three places far from each other, were made within six days.

In Table 2 the highest percentage of grain was recorded in November. This is explained by the fact that the three stomachs examined were obtained from birds shot feeding in a newly harvested rice field in Novaliches, Rizal Province.

The preponderance of rice in the stomachs of the March collection is mainly due to seven birds obtained in Baliuag, Bulacan, and one bird in Apalit, Pampanga, where the birds were noted feeding on the stubble. Examination of six birds col-

lected in May from Bulacan showed a greater percentage of rice seeds than weeds. In Table 1 there is a slight preponderance of the grain over the weeds in the collection from Bulacan. The cause of this is the result obtained from the birds secured during the two months just named and under conditions indicated. It should, however, be noted that in addition to the contents of 15 stomachs collected in October which were entirely weed seeds, 71 stomachs obtained in February, 40 in June, and 113 in December gave 12, 80, and 36 per cent weed seeds, respectively, over the percentage of rice. The figures corresponding to July represent the results of collecting for this month in 1932 and 1933. In July, 1932, only three stomachs were examined and all had nothing but weed seeds.

Collections from Rizal, Pampanga, Tarlac, Pangasinan, Zambales, and Bataan Provinces in December, 1932, resulted in an examination of 113 stomachs, the largest number of specimens studied for any one month.

Examination of 304 stomachs of barred ground doves collected in ten provinces in eleven months over a period of two years indicates that weed seeds comprised 69.9 per cent and rice 30.1 per cent of their food. It is interesting to observe that the results obtained from the examination of stomachs (weeds, 69.6 per cent; rice, 30.4 per cent) in Rizal, which represent the most complete series of materials from any one province, are closer to those of the main results than any of those of the other provinces. It is equally interesting to note the proximity of the average percentages of weeds and rice obtained from the December collection, which represent the largest number of stomachs from many collecting grounds in any one month, to the final results.

The results here obtained, although in accord with those reported by Baker,(1) Dammerman,(4) Mason,(6) and McGregor,(8) perhaps represent the first that are based on actual analysis of the stomach contents of the barred ground dove, *G. striata*. In Australia similar methods were employed in the study of its congeners, *G. humeralis*, *G. placida*, and *G. cuneata* by Clelland and others,(2) who reported them to subsist on seeds of grain and weeds.

Seeds of the following plants were recorded from stomachs of the barred ground dove:

Tiribúhan; *Panicum colonum* Linn.
Daua-daúahan; *Panicum crus-galli* Linn. and *P. distachyum* Linn.

Sabuñg-sabuñgan; *P. flavidum* Retz.
Luya-luyáhan; *Panicum repens* Linn.
Laau-láau; *Paspalum conjugatum* Berg.
Paragis; *Paspalum scrobiculatum* Linn. and *Digitaria corymbosa* (Roxb.) Merr.
Tuhog-dalag; *Cyperus compressus* Linn.
Ballayang; *Cyperus difformis* Linn., *C. iria* Linn., and *Scirpus articulatus* Linn.
Katábad; *Scleria tessellata* Willd.
Alibañgon; *Commelina benghalensis* Linn.
Alitbañgun; *Aneilema malabaricum* (Linn.) Merr.
Kadayohan; *Celosia argentea* Linn.
Golasiman; *Portulaca oleracea* Linn.
Mani-manian; *Terramus labialis* (Linn. f) Spreng.
Tabang-bayawak; *Flemingia strobilifera* (Linn.) R. Br. and *Phyllanthus simplex* Retz.
Saluyot; *Corchorus capsularis* Linn.
Bulubulúhan; *Malachra capitata* Linn. and *Melochia concatenata* Linn.
Talanuk; *Merremia gemella* (Burm. f) Hellier f.

SUMMARY AND CONCLUSIONS

1. Three hundred five stomachs of the barred ground dove were examined. One stomach containing 170 dipterous pupæ was considered accidental and was not included in the estimate.

2. The birds were collected in fifty-six places in ten provinces, all on Luzon Island, from July, 1932, to July, 1933.

3. Field observations were made in more places and through a longer period of time than actual collecting.

4. In the field the birds were noted to feed either on weed seeds and rice grains found on the ground or on seeds obtained close to the ground.

5. They were heard cooing in coco groves and in orchards, but seem always to feed on the ground.

6. The birds generally go in pairs, seldom singly, and rarely in flocks of four or six.

7. The barred ground doves are frequent visitors to rice paddies about harvest time when fallen rice seeds are abundant.

8. At other times they feed on seeds of different species of weeds.

9. Stomach examination reveals that except for one bird, which fed on dipterous pupæ, the food of the barred ground doves studied consisted of seeds of weeds and rice.

10. Due to the accessibility of Rizal Province to Manila from where collecting parties were sent at occasional intervals, a more complete representation of samples compared with other provinces has been obtained from this region.

11. The results obtained from the materials collected in Rizal Province follow closely those of the final results.

12. An extended collecting trip to secure barred ground doves in December, 1932, resulted in a collection of 112 birds, the largest number for any month.

13. The results for December, when the largest number of stomachs for any one month was obtained, are closer to the final results than any of the other months when samples were examined.

14. An average of 69.9 per cent weed seeds and 30.1 per cent rice seeds were found to be the constituents of the food of all the barred ground doves studied.

15. Seeds of 24 species of weeds were identified from the contents of the stomachs of birds studied.

The food of the barred ground doves has been found, both by field observation and by examination of their stomach contents, to be seeds of rice and weeds. Volumetric analysis indicate that weeds constitute the bulk of their food. The species is a ground feeder and the rice seeds were taken from the stubble. These observations indicate that the species is of neutral importance in its feeding habits.

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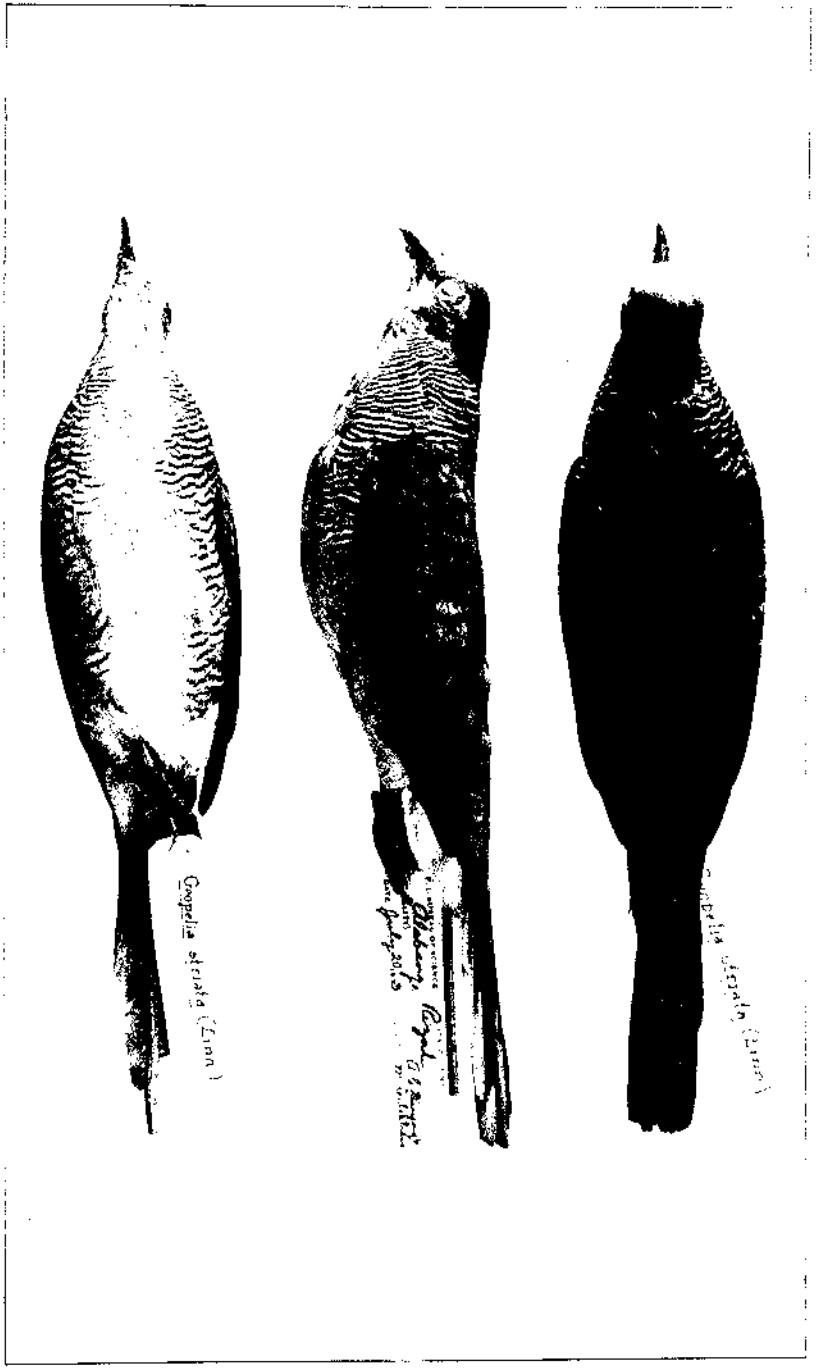
ILLUSTRATION

PLATE 1. The barred ground dove, *Geopelia striata* (Linnæus).



The barred ground dove, *Geopelia striata* (Linnæus).

PLATE 1.

METHODS OF SMOKING FISH AROUND MANILA BAY

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TWO PLATES AND THREE TEXT FIGURES

The smoking of fish is an important industry in Manila and in Malabon and Navotas, Rizal Province; and Cavite and Rosario, Cavite Province. The center of the industry in Manila is at Tondo near Bangkusay, one of the principal fish landings in the city. Here, there are thirty smoking sheds, all owned by Chinese. Outside of Manila smoking of fish is done by Filipinos, most of whom are women.

The Chinese in Manila buy their fish from fishermen of the towns of Navotas and Parañaque, Rizal Province, and Rosario, Cavite Province. Fishermen of Rosario, who are also smokehouse owners, seldom bring their fish to Manila. Their catches are mostly for local smoking. However, they send some surplus brine-cooked fish to the Manila Chinese smokers when they have more fish than they can actually smoke. In Malabon and Navotas the smokers own fish corrals or other kinds of fishing gear. Catches that are not likely to find a market in the fresh condition in Manila are taken home to be salted or smoked.

Retailers in different parts of Manila get their *tinapá* (smoked fish) from dealers in Divisoria Market. These are all Chinese who are also owners of smoking sheds, if not partners of the smokers. Wholesale buyers from Nueva Ecija, Tarlac, Pampanga, Bulacan, Rizal, Laguna, and Tayabas Provinces deal directly with the smokers in Manila, Malabon, and Navotas.

In Rosario the smokers themselves take their product to the towns of Naic, Indang, Mendez, and Alfonso, Cavite Province, and Nasugbu, a border town of Batangas Province. Occasional orders from San Pablo, Laguna Province, are also received by the smokers. Fish smoked on a small scale by smokers of the town of Cavite are mostly sold locally, although some are sent to Angeles, Pampanga Province, and Cabanatuan, Nueva Ecija Province.

The principal fish used for making tinapa are *tamban* (*Sardinella longiceps*), *lapád* (*S. perforata*), *tonsoy* or *laolao* (*S.*

fimbriata), and *kabasi* (*Anodontostoma chacunda*). The first three are species of the herring family and the fourth is a gizzard shad. All of these are caught in great quantities in Manila Bay from June to December. *Silinyasî*, the young of tonsoy, is also smoked extensively during March, April, and May. *Bañgos*, or milkfish (*Chanos chanos*), is sometimes smoked.

METHOD OF SMOKING EMPLOYED IN MANILA

Preparing the brine.—The preparation of brine is very simple. A large tub is filled with water and into this is poured the salt in small quantities. After each addition the water is stirred vigorously. The process is continued until a saturated solution of brine is obtained. Although this is an easy way of preparing the brine, the resulting solution is by no means clean. The local commercial salt is far from being free from dirt. Some dirt floats with the foam on the surface, while the rest settles to the bottom with the undissolved grains of salt.

Brine has the property of drawing blood from the fish, and the extracted blood mixes with the solution. After a time the original brine becomes saturated with fish blood and slime. When the fish have been removed, the scales and heads that may have fallen off are dipped out. The same brine is usually used over and over again for months without change. More salt is added from time to time as occasion demands.

Brining the fish.—Brining is a measure to prevent the spoilage of the fish while awaiting to be brine-cooked. The fish are brined in the round; that is, the heads and entrails are not removed. Brining the fish without washing is a general practice among the smokers. After the brining tub has been filled to capacity, the brine and fish are stirred and handfuls of salt are spread to cover the fish on the surface. Fish 10 to 14 centimeters long are immersed twenty minutes before brine-cooking; silinyasî 4.5 to 8 centimeters long, five minutes.

Brine-cooking.—The fish from the brining tub are placed in small immersion baskets (*kaing*) with a capacity of 7 to 8 kilograms. These baskets are provided with a pair of long rattan handles by which they are suspended during immersion in the boiling brine. Only one or two baskets can be placed in the kettle at a time.

The baskets are immersed about 15 centimeters below the surface of the brine in a large iron kettle having a capacity of about 95 liters. The kettle is mounted on a stone or concrete

furnace 1.7 meters square and 1.5 meters high. A rectangular hole on one side of this furnace serves both as opening of the fire box and also as smoke flue. The attendant stands at the side opposite the opening.

The time for which fish of different sizes are cooked varies. The smaller the fish the shorter the period, as shown in the following table:

Kind of fish.	Length of cooking period. Min.
Silinyasî of all sizes	1.3 to 1.5
Tonsoy	2.5 to 3
Lapád	2.5 to 3
Tamban	3 to 4.5
Kabasi	4 to 5

The weaker solution of brine is used for small fish like silinyasî. For larger fish like tamban and kabasi, a stronger solution is used. A considerable amount of saturated brine clinging to the fish from the brining tank goes into the kettle and thus helps raise the concentration of the cooking-brine. As constant evaporation also makes this brine more concentrated, fresh water is added to it occasionally during the cooking process to dilute the brine and fill the kettle. It usually takes at least three hours to finish brine-cooking all the fish in a tub of about 400 kilograms.

Smoking.—After brine-cooking, the baskets are placed on the floor to allow the fish to cool. When cool, the fish are arranged in round bamboo trays (*titai*). These are of two sizes, 7 by 46 centimeters, holding 50 kabasi or tamban and 100 tonsoy or lapád, and 6 by 36 centimeters, holding 50 tonsoy or lapád. Large fish are generally arranged overlapping one another. Silinyasî, 6 to 7.5 centimeters long, are scattered loosely in a helter-skelter arrangement. In the case of the smaller silinyasî, 4.5 to 5 centimeters long, the trays are filled to the brim. These are partially sundried before being placed in the smoking trays. In the drying yard they are placed on flakes 56 by 113 centimeters, made of coarsely woven thin strips of bamboo. Large fish are dried in the same trays in which they are smoked later. Fish that are brine-cooked in the afternoon are allowed to stand in the trays overnight and smoked the following morning. In this manner partial drying is accomplished without exposure to the sun. Partial drying hardens the fish to a certain extent and prevents breakage during subsequent handling.

In emergency cases fish are smoked without being partially dried.

The smoking furnace, usually made of blocks of adobe stone, is about 23 meters long, 1 meter wide, and 70 centimeters high. This is built on one side of the shed, never in the middle. It may be straight or it may assume any shape, depending on the shed where it is built. It is provided with 28 to 30 smoking chambers, 35 to 37 centimeters in diameter, 24.5 to 28 centimeters apart. The depths range from 80 to 82 centimeters. Each smoking hole is fueled with sawdust independently. The air necessary for the combustion in the smoking chamber is admitted through an opening 3.2 centimeters in diameter placed in front, 25.5 centimeters from the top. Crumpled paper plugged in these openings loosely or tightly, as the case may be, serves to regulate the amount of air admitted to the smoking chamber.

Charcoal is made to glow usually in the last unit of the furnace. Occasionally a specially constructed unit may be found separate and not far from the furnace. Glowing charcoal is placed at the bottom of each hole and then covered with sawdust of *tañgili* [*Shorea polysperma* (Blanco) Merrill], or red *lauan* (*Shorea negrosensis* Foxworthy), or a mixture of the two. In front of the furnace are placed tubs of sawdust convenient to the attendant.

One to two trays of fish are placed over each opening. They are covered with round bamboo baskets 19 centimeters deep and 58.5 centimeters in diameter to confine the smoke about the fish. The period of smoking varies with the size of the fish and the kind of product, whether intended for local markets or for provincial retailers. Generally the larger the fish the longer the exposure to the smoke. Products sent to the provinces must keep longer and therefore must be smoked longer than those intended for the local markets. The following table shows the length of smoking for the different kinds of fish:

Kind of fish.	Length of smoking period. Mins.
Silinyasî (4.5 to 6 centimeters long)*	135 to 140
Silinyasî (6 to 8 centimeters long)	30 to 40
Tonsoy	45 to 60
Lapád	60 to 105
Kabasi	100 to 110
Tamban	100 to 120

* These small fish are packed thickly in the tray and cannot be thoroughly and uniformly smoked within a short time. They are turned over four times during the process, at intervals of at least 25 minutes, so that the time of smoking is lengthened.

At intervals of 10 to 40 minutes, depending upon the temperature and the kind of fish, the trays are shifted and additional sawdust is dropped into each hole. In shifting, the tray on the first hole is placed to the rear, then a heaping handful of sawdust is dropped in before the tray from the next opening is placed on it. The contents of the tray is slightly shaken in order to prevent the fish from sticking to each other and to the bottom of the tray. In case there are two trays over a hole, the one below is placed on top of the other.

After smoking, the trays are removed and placed on the floor to cool. Sometimes the exposed side of the fish is smeared with olive oil to give it a glossy appearance. When the furnace is used continuously for two or three days the temperature rises to as high as 150° C. The heat is not maintained at a uniform temperature. Soon after sawdust is added, the temperature goes down, to rise again gradually. The lowest temperature taken was 77° C. The furnace cools after two or three days' stop in the operation. In this event the smoking period is lengthened 15 to 20 minutes and more sawdust is used.

Packing.—Smoked fish for the local trade are not packed for delivery to the market. They are taken to the Divisoria market, the distributing center for tinapa in Manila, by carriers in the trays in which they were smoked. For provincial wholesale buyers who purchase the product direct from the smokers, the fish are packed in coarsely woven bamboo baskets with the sides and bottom lined with several layers of newspapers. Before packing the fish must be allowed to cool completely. If this is not done, the moisture in the fish is prevented from escaping, so that the fish become very soft and are liable to become moldy in a short time, especially during rainy days.

SMOKING OF FISH OUTSIDE MANILA

In Malabon and Navotas fish are smoked in the same way as in Manila.

The method used by the smokers in Cavite, Cavite Province, is an adaptation on a small scale of the Manila method. Instead of a long furnace, individual *pilones*[1] set in upright position are used as smokers. The usual number of pilones in a shed is six. Another deviation from the Chinese practice is that the brine in which the fish are immersed before cooking

[1] These are muscovado containers made of baked potter's clay. They are shaped like beehives with a round hole on top.

after being used twice, at the most, is discarded and a fresh lot is prepared. The brining tubs are also kept very clean.

The following method is used in Rosario, Cavite Province:

Cleaning and drying.—Before being taken to the shore the fish are washed in sea water to remove the dirt and slime. The carrier does the washing in the baskets on the way to the shore. The fish are then arranged to be partially dried under the sun on pieces of *banatan* or *baklad*, 1 by 2.5 meters long. These banatan which serve as flakes are made of small rounded splints of bamboo, "woven together with three to five lacings of *hagnaya* (*Polygala venenosa* Tuss.)." When the scales and the skin of the side exposed are sufficiently dry, the fish are turned over to dry the other side.

Partial drying is necessary in order to dry the scales and toughen the skin. Moisture in the scales causes them to fall off during cooking. The belly of unbrined fish breaks usually when cooked wet.

Brine-cooking.—From the drying yard the fish are taken to the smoking shed to be cooked in strong brine. Sea water is used in preparing the brine. When the cooking is over the clear liquid is stored in a tub to be used the next time. This brine is used over and over again with the addition of salt and sea water.

A kettle of 95-liter capacity is generally used. It is filled to within 4 centimeters of the brim. The fish are placed a few at a time into the boiling brine, and allowed to stay there five to seven and one-half minutes. To keep the fish submerged, a circular traylike affair, called *panakip*, made of bamboo, is placed over them with a weight. Every now and then the floating scum is scooped off. A paddle-shaped, flat spoon (*panandok*) (fig. 1) made of perforated copper sheet, is used in taking the fish out. From the kettle the fish are placed on a bamboo flake (*kapeng*) to drain and cool. After cooling they are arranged on racks (*daleyráyan*) (fig. 2) ready for smoking.

Smoking.—A shallow pit with a circular wall of earth, stone, or concrete serves as the smoker. The inside of the pit is formed like a shallow bowl, so much so that the whole affair looks like a large mortar (fig. 3). The height of the wall with a varying thickness of 22 to 28 centimeters does not exceed 67 centimeters. The individual holes are from 94.5 to 167 centimeters inside diameter and 70 to 77 centimeters deep from the top of the wall. A large round bamboo basket 21 centimeters

deep is used as a cover to confine the smoke in the smoking chamber. This basket has a rim diameter 10 centimeters greater than the inside diameter of the hole. Above the open-

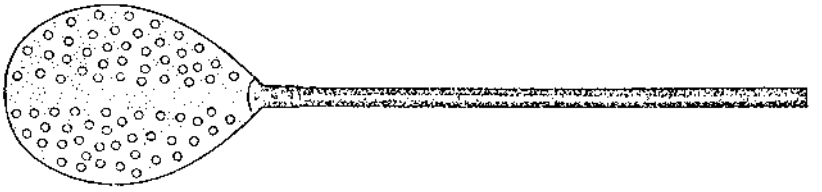

FIG. 1. Panandok.

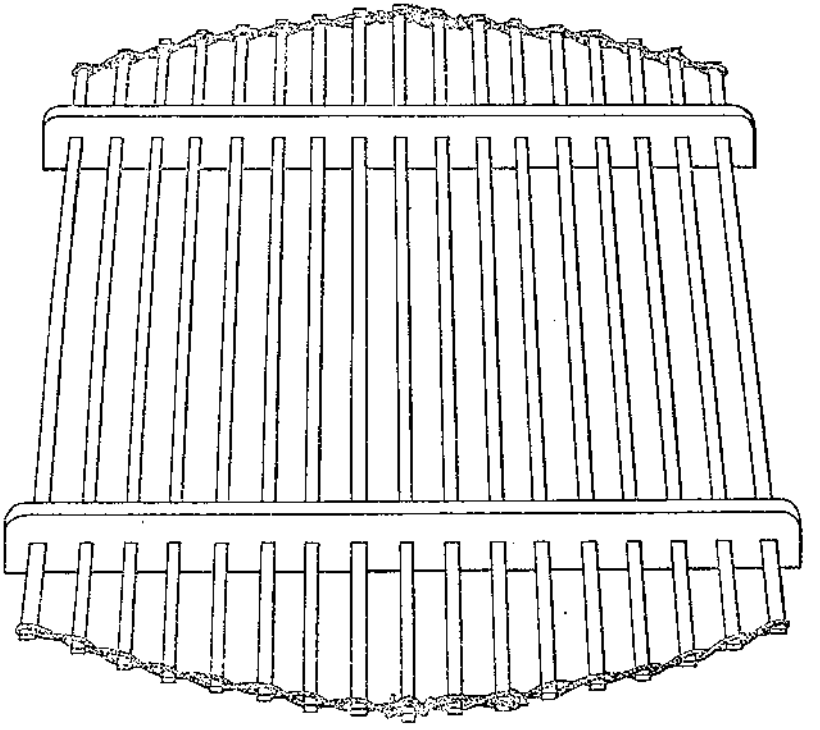

FIG. 2. Daleyráyan.

ning are suspended two hooks which serve as supports for the cover when the hole is opened.

The rack (daleyráyan) on which the fish are smoked consists of a number of bamboo sticks thrust through two wooden frames. The fish are arranged side by side on their backs at

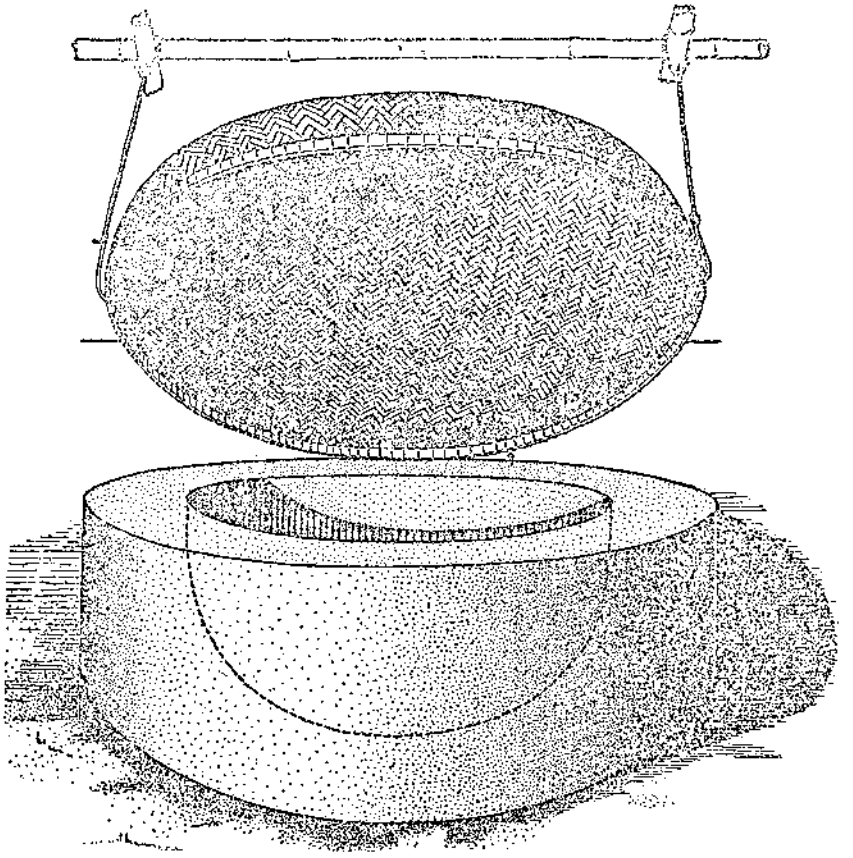

FIG. 3. Smoking hole used in Rosario, Cavite Province.

right angles with the sticks. The smallest rack holds 1,000 fish and the largest 1,500 to 1,800.

The rack is placed on the hole and covered. The rim of the cover is slightly raised in front in order to admit the necessary air for combustion. Instead of sawdust, sugar-cane bagasse and wood chips are used, the former being the main fuel. The smoke is watched, and when no longer dense, more fuel is added. After forty to sixty minutes smoking the rack is taken out. The fish are reset in order to prevent them from sticking to each other. They are again smoked for practically the same length of time.

The temperature of the smoking chamber taken immediately below the center of the rack ranges from 110° to 130° C. during the operation.

REMARKS

The tinapa is a clean product when it has been cooked and smoked properly. Improperly prepared, tinapa will not keep well. To turn out a product of acceptable quality, smokers, of Manila particularly, should pay more attention to sanitation. In Manila the fish are immersed in brine without washing and the same old brine is used over and over again for months. Although strong, this brine is saturated with fish blood and slime and is thus dirty and unfit for use. The floors of the smoking sheds, with the exception of a few which are paved with concrete, are bare earth. This is true not only in Manila but also in Malabon, Navotas, Cavite, and Rosario. Also the placing of brine-cooked fish in trays or on racks and the cooling and packing of the smoked product are done on dirty floors.

Of all smoking sheds visited only those in Rosario are neat, clean, and roomy. The elimination of the brining before brine-cooking and the use of a single smoking hole with a much greater capacity are factors that contribute to ease in maintaining the neatness of the shed. Although they employ the same method as that used by the Chinese in Manila, the smokers of Malabon, Navotas, and Cavite handle the fish in a more sanitary manner.

RECOMMENDATIONS

Brining the fish without washing off the slime and dirt should be avoided. Fresh clean brine should be always used. After being used once or twice, the brine should be discarded and the tub cleaned. Brine can be prepared by the use of two tubs (barrels will do) and a large wooden tank set at different levels. The first tub is kept filled with salt. Water flowing continuously but slowly is admitted from its bottom. The saturated brine that overflows from it is collected in the second tub where the dirt settles. The overflow from this settling tub is collected in the wooden tank. It is more convenient to place these brine containers on an elevated platform. In this manner it will be easier to draw the brine from the tank to any part of the shed by means of a hose.

The use of clean, pure salt for all purposes should be encouraged. Pure salt penetrates the fish flesh readily and thus brings about quicker preservation.

The common practice is to use old, dirty newspapers for wrapping and cheap, coarsely woven bamboo baskets lined with newspapers for packing smoked fish. This practice should be discouraged and smokers should be taught to follow the modern method of using transparent paper for wrapping and carton or wooden boxes for packing.

For the sake of cleanliness and the comfort of the workers, working tables should be provided by all means. The floor of the shed should be paved with concrete and washed frequently.

The lack of discrimination on the part of the buying public and the apathy of the fish smokers towards modern ways and methods are factors hindering the improvement of the locally produced smoked fish. The public health authorities should frame regulations that will improve the sanitary condition of the smoking sheds and the quality of the product. More frequent inspections of the smoking sheds and proper enforcement of sanitary regulations in the municipalities and in Manila along the line mentioned above will elevate fish-smoking to a sanitary and profitable industry.

ILLUSTRATIONS

PLATE 1

FIG. 1. Placing brined fish in immersion baskets for brine-cooking. (Taken at Manila.)

2. The furnace with the kettle where the fish are brine-cooked. (Taken at Manila.)

PLATE 2

FIG. 1. Brine-cooked fish (*kabasi*) being partially dried under the sun in trays before smoking. (Taken at Manila.)

2. Interior of a smoking shed showing the smoking furnace, tubs of sawdust, and a pile of empty trays. The trays on the left foreground have just been removed from the furnace. (Taken at Manila.)

TEXT FIGURES

FIG. 1. Panandok.

2. Deleyráyan.

3. Smoking hole used in Rosario, Cavite Province.

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PLATE 1.

1

2

PLATE 2.